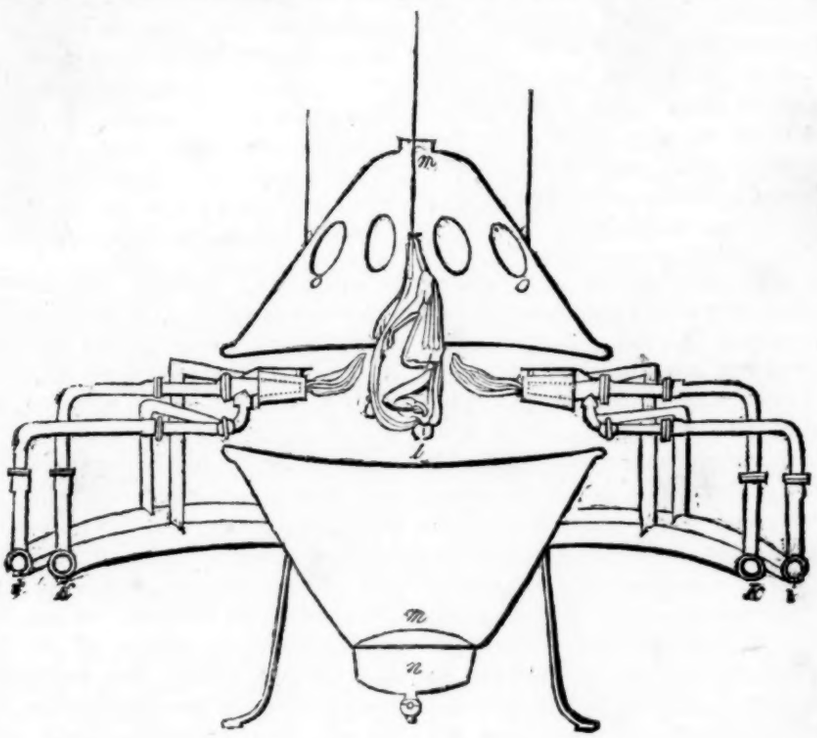
MECHANICS' MAGAZINE,

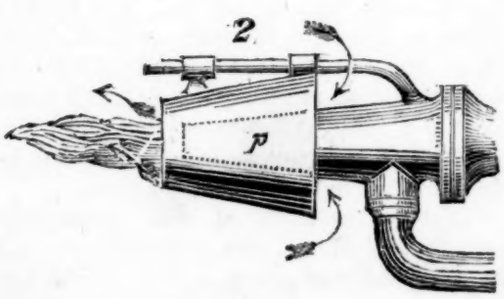
AND

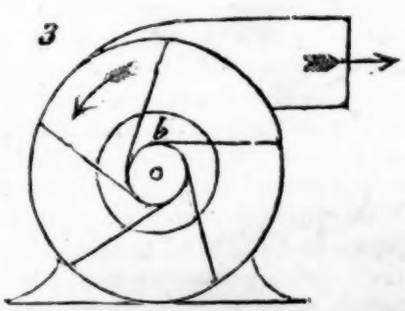
REGISTER OF INVENTIONS AND IMPROVEMENTS.

VOLUME II.] NOVEMBER, 1833. [NUMBER 5.

By looking into physical causes our minds are opened and enlarged; and in this pursuit, whether we take or whether we lose the game, the chase is certainly of service.—BURKE.





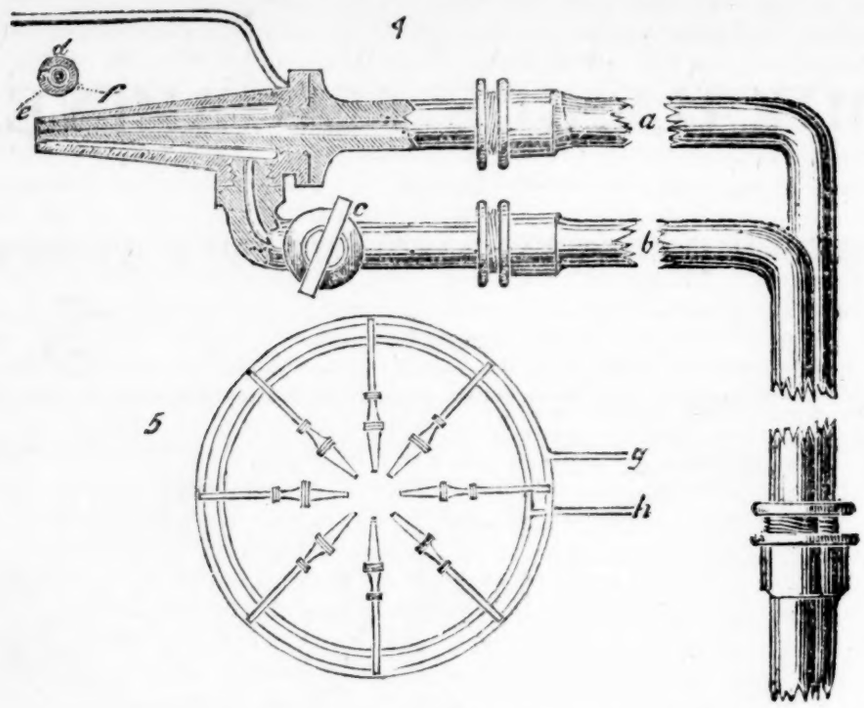


Mallet's Apparatus for cooking by Gas Flame.

[From the London Mechanics' Magazine for August.]

We extract from the last part of Mr. Loudon's "Encyclopædia of Cottage, Farm, and Villa Architecture," the following account, by Mr. Mallet, of Dublin, of an apparatus for cooking by gas flame, which he considers superior to that of Mr. Hicks:

"Cooking by gas flame is a thing which has long floated in my head, but which I have said nothing of, lest the folks should suppose me "daft," as they say in your country. Some few years ago I had occa-



sion to make some weldings of iron, where it is an important object that the metal should not be burnt away in the fire; for this purpose I endeavored to use a kind of huge gas blow-pipe. I got one made of the kind shown in fig. 4, as far as each jet is concerned, but of a much larger size. In this figure, *a* is the air tube; *b* is the gas tube; *c* the gas cock; and *d* an end view of the point of the blow-pipe, in which *e* is the circular orifice for the emission of air, and *f* that for the emission of gas. Mr. Daniell, of King's College, London, has since published the same thing as new, and of his invention; however, I can establish priority by my laboratory journal. To proceed, the jet or blow-pipe is so made that a current of atmospheric air is forced into the centre of the gas flame, by which means the latter is converted into a blow-pipe of great power. Instead of a mere circle of gas burners I use a certain number of such blow-pipe flames, arranged as radii of a circle, as in fig. 5, in which *g* is the air pipe, and *h* the gas pipe; and each of the branches to the jets from these pipes has four small collars of leather, or stuffing boxes, so that any one can be approached to or drawn from the centre of the circle, or raised or lowered, as occasion may require. Fig. 1 is a sectional view of such an apparatus complete, in action; a circular main tube, *i*, supplies the gas to all, and another, *k*, supplies the current of air. the means for producing which I will describe hereafter. The article to be roasted, *l*, is suspended from a bottle jack, but with a swivel such as those used by anglers interposed, so that it may be permitted to turn, or be stopped, the jack still going on as may be required. Above and below it are parabolic plated copper reflectors, *m m*; the lower one with a receptacle for dripping, *n*; and the upper one with six or eight discs of plate glass inserted in proper places to enable the operator to view the process of coction. Each burner has a copper cone, *p*, placed so as to slide over it, by which means the radiated heat, convergent on the roasting matter, a current of hot air is continually urged against it, as shown more fully in fig. 2. The upper reflector is hung by balance weights, so as to throw up in a moment; and besides a cock to each individual gas tube of each burner, there is a general one to each of the air and gas main tubes, so as to diminish the heat generally, or in any particular spot.

"The advantages of this arrangement over that of Mr. Hicks appear to me to be a much greater economy in fuel, (as the waste heat in the upper reflector may be collected and conveyed away in a tube, and applied for the purpose of heating water, &c.;) perfect combustion, at a greatly increased temperature (viz. one sufficient to melt wrought iron), without any smoke; the means of a more perfect regulation, application, and adaptation of the heat to any given substance;

better form for the reflectors, and less escape of heated air by them; the application of copper funnels to the burners, by which a continuous current of hot air is urged against the article being roasted; and the capability of adapting the cordon of burners to an irregular mass, at equal distances every where.

"The expense of this apparatus is far greater than that of Mr. Hicks, but fewer sets of apparatus will answer by this than by that mode; for the common circle will only suit things of nearly the same size, while my apparatus may be applied to any thing that can be admitted within it.

"The current of air may be produced by means of fanners, such as are occasionally used for producing a blast on a large scale in iron founderies. These are to be worked either by a common jack, (a smoke-jack,) or any other power at hand. The fanners are simply a few vanes of sheet iron, revolving with great rapidity (1500 times per minute) in a cylindrical case, with a lateral aperture for the emission, and two others at the axis for the admission of air, as in fig. 3. The vanes are set tangentially to the axis, and so revolve, that by communicating a centrifugal force to the air in the cylinder, it is expelled at *a* and fresh air drawn in at *b*, to be in its turn expelled likewise. Mr. Daniell proposed to heat the air in a red-hot tube, for the purpose of this blow-pipe, which would certainly be an improvement, and could readily be done by inserting the tube in the kitchen fire.

"Blow-pipe flames for boiling or stewing may be made on the same principles, and those described, only placed vertically, will do; all that is necessary is that several concentric alternate tubes of gas and air may be burnt. But I do not conceive cooking generally by gas, in the present state of the gas manufacture, and consequent high price of gas, economical. I however esteem it admirably applicable to cooking wild fowl, and similar exquisite *morceaux* of *gourmanderie*. When gas is publicly made from the decomposition of water (and I think the time is not far distant when that will be the case), it will be a cheap fuel for many purposes."

Remarks by Mr. Loudon, Editor of the London Gardeners' Magazine.—"We do not offer an opinion on Mr. Mallet's plan for cooking by gas, as compared with that of Mr. Hicks, but the more we see and hear on the subject generally, the more we are convinced that the time is not far distant that cooking by gas will become common in all towns where gas lighting is employed. Our correspondent, Mr. Robison, informs us that Messrs. Steele, brothers, ironmongers in Edinburgh, are about to erect a kitchen for a gentleman in the neighborhood of that city on the plan given in page 714 of this work, but substituting gas stoves for the coke fires, and adding a roasting and baking oven, both heated by gas. A canopy is to be put up over the cooking hearth, like the sounding board of a pulpit, and its apex is to be connected with a flue in the kitchen wall, by which means all smells produced by cooking will be carried off as fast as generated. Mr. Milne, an eminent brass-founder in Edinburgh, who has had great experience in fitting up gas apparatus, both in England and Scotland, is of opinion that, in the city just mentioned, gas, in the better class of houses, will soon take the place of coal fires, not only for cooking, but also for heating. We have lately seen not only roasting, but boiling and stewing performed at Mr. Hicks', and earthen-ware cones and radiating discs substituted for metallic ones, in a similar manner to that suggested by Mr. Mallet. For broiling, a disc is substituted for a cone."

National Gallery of Practical Science, London. [From the Repertory of Patent Inventions for August, 1833.]

It is surprizing, amongst the numerous scientific institutions which are so liberally supported in this country, that till within a short period there should have been none which had for its express object the advancement of mechanical science. We had long considered that an institution of this character would meet with the most extensive support, and are not disappointed, for in our visits to the *National Gallery of Practical Science* we daily meet with some new subject for our consideration, though we have constantly to elbow our way to any object which we are desirous of examining, particularly should our visit be late in the day.

Several subscription *soirees*, under the patronage of His Royal Highness the Duke of Sussex, have also been held at this institution. On each evening, a conversation on some practical application of the sciences has been given; in addition to which, numerous models, and other subjects of interest, were arranged in various parts of the gallery. At some of these meetings we had the pleasure of being present, and cannot but congratu-

late the managers in having broken through the barrier which heretofore excluded ladies from joining these highly intellectual treats.

The object of this institution is to afford every possible encouragement and facility for the practical demonstration of discoveries in natural philosophy, and for exhibiting new applications of known principles to mechanical contrivances of general utility. In pursuance of these objects, several highly valuable and interesting experiments have already been tried; amongst others, may be mentioned a series of experiments on the production of high velocities to track-boats, such as have been some time in use on the Paisley canal. It had been stated, though not generally believed, that these boats, when caused to travel at a speed of from ten to twelve miles the hour, did not offer so much resistance as when travelling at lower speeds; this soon became a question of great importance to every engineer, as well as others; more particularly to those who were directly or indirectly interested in canal property, and hence an extensive experiment was gone into, under the superintendance of Mr. Telford, aided by other eminent engineers. The canal in the national gallery offering every convenience, the results were satisfactory, and will be highly useful in improving this description of conveyance. It was proved that, by the application of means to produce high speeds to these boats, they have a tendency to rise to the surface and displace less water, and consequently do not require a greatly increasing power to propel them as was generally considered. These experiments afterwards led to one of the Paisley boats being brought to the Paddington canal, and a continuation of experiments on the large scale. This boat was drawn by fast horses at the rate of from ten to fifteen miles the hour, and similar results were obtained as upon the smaller scale; and we believe that all parties were satisfied, that a speed of at least twelve miles an hour on our canals will soon become general, though we do not consider that horses will be so well adapted to this purpose as fixed engines.

There have also been a series of experiments made in respect to the application of undulating railroads, according to the proposition of Mr. Badnall. We were not present at any of the trials, but in our last number we gave our opinion of what might be expected to result from such an application. We have mentioned these two experiments in the first place, because they are not mentioned in the catalogue, to which we will now turn, taking the different subjects according to their numerical order.

No. 1. *Newly discovered System of generating Steam. By Jacob Perkins.*—This very simple yet beautiful system of generating steam, is, we understand, getting into use in fixed engines, in steamboats, and has been tried for a length of time on the Liverpool and Manchester railroads, with every prospect of the most decided success. The average distance which the locomotive carriages travel, before the tubes of the boiler are destroyed, is about 3000 miles. The carriage in which Mr. Perkins' system of circulation is applied, has travelled upwards of 20,000 miles without the tubes giving way. In consequence of these results, the directors have caused two new carriages to be constructed, which are to be in every way alike, excepting that to one is to be added the plates to produce the circulation of the water. The working of these two carriages will determine, in a great measure, the value of Mr. Perkins' invention, as applied to this description of boiler. But this principle of generating steam is also extensively applicable in the production and manufacture of spirits, sugar, salt, indigo, soda, soap, and other articles depending on ebullition with continuous circulation.

No. 2. *Steam Gun. By the same.*—We recommend our country, as well as our town readers, to take the first opportunity to see this destructive engine: nothing can better exemplify the powers of steam. This instrument is capable of throwing, in any direction, a stream of seventy balls in four seconds, with a strength equal to gunpowder.

No. 3. *Combustion of the Hardest Steel. By the same.*—A disc of soft iron, to which motion is given by a steam engine, attached to the boiler of the steam gun, is turned with a velocity of 5,400 revolutions in a minute; and by placing a file, or other piece of the highest tempered steel, in contact with the periphery of the disc, the friction caused by the soft iron destroys or cuts the steel, producing thereby a brilliant and beautiful combustion.

The peculiar result produced by this instrument is very interesting. A machine on similar principles has lately been patented for cutting and grooving marble, by the use of a circular disc of soft metal, which revolves with immense velocity.

No. 4. *Compression of Water. By the same.*—An apparatus which, by hydrostatic pressure, compresses water to an extent

equal to a fourteenth part of its volume. The force employed is equivalent to a pressure of 30,000 lbs. to the square inch, and is applicable to other liquids.

In most of our works on natural philosophy water is treated as incompressible and non-elastic; by this apparatus the opposite of these two propositions is clearly shown. There was considerable difficulty in getting a vessel capable of resisting so high a pressure; and the chief feature of this instrument is the manner of constructing the cylinder, which is formed of a series of concentric tubes; thus the inner or smaller tube is first formed by welding, and is turned accurately on the outer surface; the next tube is then formed, and is accurately turned on the inner surface, and the bore of this second or outer tube is just too small to receive the first tube; but in order that it may do so, it is heated, till, by expansion, it is capable of receiving the first tube within it, and in cooling, the second tube shrinks on the first tube, and strongly embraces them together; a third tube, a fourth, and so on, are similarly put on till a cylinder is produced capable of withstanding any extent of pressure.

No. 5. Steel Engraving, and Unlimited Transfer or Reproduction of the Subject or Design. By the same.—Some of the most beautiful and highly finished engravings of the present day are produced by the exercise of this invention; to effect which a steel plate is first softened to such a state of ductility as to permit the engraver to use the finest tools with nearly the same ease as on a copper-plate. When the design is finished, the plate is hardened by a process of carbonization, and it is then not only available to the production of a hundred times as many impressions as a copper-plate would yield, but is also made the means of forming other plates, almost *ad infinitum*, by transfer of the subject thereto in perfect *fac simile*.

This transfer is made by passing a cylindrical piece of softened steel over the hardened plate, with a pressure sufficient to give it a complete impression *in relievo;* and this cylinder, being hardened, is then used to transfer the subject to any required number of soft plates, which plates may again be used, by a similar process, in endless reproduction.

To Mr. Perkins we are greatly indebted for his discoveries in this branch of the arts: he may be said to be the father of steel plate printing. In a manufacturing point of view this invention is most highly valuable: the power of multiplying plates, whether on steel or copper, by this ingenious means of transferring designs from hardened surfaces, is unlimited; any number of plates of soft metal may be produced from one engraving by the artist, which may be afterwards hardened. The printers of silks, muslins, calicoes, &c. are thus enabled to expend large sums of money in paying the best artists for designing over a small surface, and executing the same in the best manner of their art. Their design may then be multiplied to the extent required, particularly in covering the whole surface of printing cylinders, which is now very commonly practised.

Libraries for Working Men.—It affords us great pleasure to observe that, in several towns and villages, the mechanic and the laborer may now obtain useful and amusing books to read upon the payment of a very small subscription. Such institutions we have no doubt will become generally established. Sir John Herschel has recently published an address delivered at Windsor (England), before an institution recently formed there, which is accessible for the trifling payment of one penny per week, from which we select the following extract:

"Of all the amusements which can possibly be imagined for a hard-working man, after his daily toil, or in its intervals, there is nothing like reading an entertaining book, supposing him to have a taste for it, and supposing him to have the book to read. It calls for no bodily exertion, of which he has had enough or too much. It relieves his home of its dullness and sameness, which, in nine cases out of ten, is what drives him out to the ale-house, to his own ruin and his family's. It transports him into a livelier, and gayer, and more diversified and interesting scene; and while he enjoys himself there, he may forget the evils of the present moment, fully as much as if he were ever so drunk, with the great advantage of finding himself the next day with his money in his pocket, or at least laid out in real necessaries and comforts for himself and his family, —and without a headache. Nay, it accompanies him to his next day's work, and if the book he has been reading be any thing above the very idlest and lightest, gives him something to think of besides the mere mechanical drudgery of his every-day occupation,—something he can enjoy while absent, and look forward with pleasure to return to.

"But supposing him to have been fortunate in the choice of his book, and to have alighted upon one really good and of a good class, what a source of domestic enjoyment is laid open! What a bond of family union! He may read it aloud, or make his wife read it, or his eldest boy or girl, or pass it round from hand to hand. All have the benefit of it—all contribute to the gratification of the rest,—and a feeling of common interest and pleasure is excited. Nothing unites people like companionship in intellectual enjoyment. It does more, it gives them mutual respect, and to each among them self-respect—that corner-stone of all virtue. It furnishes to each the master-key by which he may avail himself of his privilege as an intellectual being, to

> 'Enter the sacred temple of his breast,
> And gaze and wander there a ravished guest;
> Wander through all the glories of his mind,
> Gaze upon all the treasures he shall find.'

And while thus leading him to look within his own bosom for the ultimate sources of his happiness, warns him at the same time to be cautious how he defiles and desecrates that inward and most glorious of temples."

On facilitating the Advancement of Useful Improvements. By S. Blydenburgh. To the Editor of the Mechanics' Magazine.

Lansingburgh, Nov. 9, 1833.

Sir,—We often speak of the present as emphatically and peculiarly an *age of invention*, without, I think, sufficiently adverting to the cause or causes which make it so, as an investigation of the subject might lead to circumstances which would facilitate the advancement of useful improvements.

The first exciting cause is doubtless that degree of civil liberty which leaves the human mind untrammelled to avail itself of its own strength. But, as soon as the first latent spark of inventive genius awakens into action, those inventive faculties, so peculiar to the human character, become excited and urged on by a spirit of emulation: invention follows invention; new, unthought-of, and even incredible effects are produced; and so prolific is human ingenuity, that a single but successful effort of inventive genius causes a change in society from a state of ignorance to an age of wonderful inventions.

I have been more particularly convinced of the truth of these remarks, by observing what has been effected in this neighborhood within a short time.

About six months ago, Mr. Fairman, of this place, completed a compound rotary steam engine, and a machine for making wrought nails, both of which were noticed in your Magazine; until which time nothing had been effected here to mark the time or place as peculiar for any uncommon display of inventive talent. But the spirit of invention seemed suddenly to awaken, and a train of new, and many of them useful inventions, has followed, a catalogue of which would almost exceed credibility, even in the mind of the most enthusiastic projector. I will give you a list of those which occur to my recollection, omitting for the present the names of the inventors, but will furnish you with descriptions, and perhaps drawings, of the principal ones, for your succeeding numbers, should you think them worthy of publication.

My object in this little communication is to show how far the advancement of useful improvements may be accelerated, not only by exciting a spirit of emulation, but more especially by co-operation. It must be obvious to any reflecting mind, that the united efforts of persons of mechanical genius must produce a result nearly as the square of their numbers. What then might we not expect from properly organized associations, since nearly all that has yet been done has been the effect of unassisted genius, and frequently under all the embarrassments of poverty, if not of public ridicule?

The list of inventions above alluded to, within about six months, and within the compass of ten adjoining square miles, contains the following, and probably some others not now in my recollection: A rotary steam engine—two wrought nail machines—three pumps for kitchens and other domestic uses—one pair of self-moving temples—a magic liquor pump, equally wonderful and useful—a steamboat, which will probably supercede all others—a stocking frame, which makes by water or steam four stockings at once, one inch per minute on each—an improvement in the speeder for spinning cotton—and an improved water-wheel.

Yours, respectfully,

S. Blydenburgh.

[We hope our esteemed correspondent will continue his communications, and that he will favor us with detailed descriptions and drawings of the important inventions he has enumerated; it is to such men that we look for valuable information, and if we could but get such a correspondent in each state, it would add very greatly to the value and utility of this Magazine.—Ed. M. M.]

History of Chemistry. [Continued from page 205.]

Of the Metals.—The metals are the next class of bodies which fall to be described in the order which we have laid down, for treating of the various substances to be noticed in this part of the present work.

We shall therefore now enter upon the description of these brilliant bodies, so useful to society; which so highly influence public and individual prosperity, not only by their real properties, but by the ideal value attached to them; which have, on the one hand, rendered such eminent services to humanity, and, on the other, produced so many evils; which at the same time mark the industry of nations and add to the improvement of human reason, while they so often become the instruments, and almost the cause, of the depravation, the misery, and all the evils, which afflict mankind. There are no productions of nature which excite a higher degree of interest in their study, or which have given rise to so many discoveries: there are not, consequently, any substances which deserve to be treated more fully, or with greater care.

The multiplied uses to which the metals are applicable, do not constitute the only reason why they should be described with accuracy, and studied with attention. The vast influence which they have had on the progress of chemistry, the discoveries which relate to them, particularly in modern times, and the perfection which they have added to human reason, render them of the greatest consequence to those who cultivate natural philosophy. On the properties of these bodies depend the mariner's compass, the arts of printing, of navigation, and astronomy, and every other science, which are most truly honorable to the genius of man. There is, in truth, no art which can be carried on without the metals. They are the first movers and primary instruments of almost every workshop. There is scarcely a single circumstance of life in which we do not derive continual services, or in which we are not subjected to dangers, from their energy. The metals are friends which serve us, and which it is desirable we should always have near us; or they are enemies pressed into our employ, which it is consequently of importance that we should know how to subdue, and sometimes to coerce.

So sensible were the ancients of their great importance, that they raised those persons who first discovered the art of working them to the rank of deities. In Chemistry they have always filled a conspicuous station: at one period the whole science was confined to them; and it may be said to have owed its very existence to a rage for making and transmuting metals.

One of the most conspicuous properties of the metals is a particular brilliancy which they possess, and which has been called the *metallic lustre*. There are other bodies, indeed, (*mica*, for instance,) which apparently possess this peculiar lustre; but in them it is confined to the surface, and accordingly disappears when they are scratched; whereas it pervades every part of the metals. This lustre is occasioned by their reflecting much more light than any other bodies: a property which seems to depend partly on the close ness of their texture. This renders them peculiarly proper for mirrors, of which they always form the basis.

They are perfectly opaque, or impervious to light, even after they have been reduced to very thin plates. Silver leaf, for instance, $\frac{1}{186000}$ of an inch thick, does not permit the smallest ray of light to pass through it. Gold, however, when very thin, is not absolutely opaque; for gold leaf $\frac{1}{282000}$ of an inch thick, when held between the eye and the light, appears of a lively green, and must, therefore, as Newton first remarked, transmit the green colored rays. It is not improbable that all other metals, as the same philosopher supposed, would also transmit light, if they could be reduced to a sufficient degree of thinness. It is to this opacity that a part of the excellence of the metals, as mirrors, is owing; their brilliancy alone would not qualify them for that purpose.

Most of them may be melted by the application of heat, and even then still retain their opacity. This property enables us to cast them in moulds, and then to give them any shape we please. In this manner many elegant iron utensils are formed. Different metals differ exceedingly from each other in their fusibility. Mercury is so very fusible, that it is always fluid at the ordinary temperature of the atmosphere; while other metals, as platinum, cannot be melted except by the most violent heat which it is possible to produce.

In general, their specific gravity is much greater than that of any other body at present known. Potassium, one of the lightest of them, is, however, lighter than water; and the specific gravity of platinum, the heaviest of all the metals, is 23. This great

density, no doubt, contributes considerably to the reflection of that great quantity of light which constitutes the metallic lustre.

They are the best conductors of electricity of all the bodies hitherto tried.

None of the metals are very hard; but some of them may be hardened by art to such a degree as to exceed the hardness of almost all other bodies. Hence the numerous cutting instruments which the moderns make of steel, and which the ancients made of a combination of copper and tin.

The elasticity of the malleable metals depends upon their hardness; and it may be increased by the same process by which their hardness is increased. Thus, the steel of which the balance springs of watches are made is almost perfectly elastic, though iron in its natural state possesses but little elasticity.

But one of their most important properties is *malleability*, by which is meant the capacity of being extended and flattened when struck with a hammer. This property, which is peculiar to metals, enables us to give the metallic body any form we think proper, and thus renders it easy for us to convert them into the various instruments for which we have occasion. All metals do not possess this property; but almost all those which were known to the ancients have it. Heat increases this property considerably. Metals become harder and denser by being hammered.

Another property, which is also wanting in many of the metals, is *ductility*, by which we mean the capacity of being drawn out into wire, by being forced through holes of various diameters.

Ductility depends, in some measure, on another property which metals possess, namely, *tenacity;* by which is meant the power which a metallic wire of a given diameter has of resisting, without breaking, the action of a weight suspended from its extremity. Metals differ exceedingly from each other in their tenacity. An iron wire, for instance, $\frac{1}{10}$ of an inch in diameter, will support, without breaking, about 500 pounds weight; whereas a lead wire, of the same diameter, will not support above 29 pounds.

When metals are exposed to the action of heat and air, most of them lose their lustre, and are gradually converted into earthy-like powders of different colors and properties, according to the metal and the degree of heat employed. Several of them even take fire when exposed to a strong heat; and after combustion, the residuum is found to be the very same earthy-like substance.

All metals, even the few that resist the action of heat and air, undergo a similar change when exposed to acids, especially the sulphuric, the nitric, and the muriatic, or a mixture of the two last. All metals by these means may be converted into powders, which have no resemblance to the metals from which they were obtained. These powders were formerly called *calces*, but at present they are better known by the name of *oxides*. They are of various colors, according to the metal and the treatment, and are frequently manufactured in large quantities to serve as paints.

When these oxides are mixed with charcoal powder and heated in a crucible, they lose their earthy appearance, and are changed again into the metals from which they were produced. Oil, tallow, hydrogen gas, and other combustible bodies, may be often substituted for charcoal. By this operation, which is called the *reduction* of the oxides, the cumbustible is diminished, and, indeed, undergoes the very same change as when it is burned.

No metal can be converted into an oxide except some substance be present which contains oxygen; and during the oxydizement, a portion of that oxygen disappears.

There are some metallic oxides which can be reduced by the application of heat in close vessels. Now, whenever they are reduced in that manner, they yield oxygen gas; and the weight of the oxygen, together with that of the metal obtained, is equal to the weight of the original oxide. Thus, when the oxide of mercury is heated in a retort, to which a pneumatic apparatus is attached, to the temperature of 1000°, it is converted into pure mercury; and, at the same time, a quantity of oxygen separates from it in a gaseous form. The weights of the metal and the oxygen gas are together equal to that of the oxide; the calx of mercury, therefore, must be composed of mercury and oxygen only. Its calcination is merely the act of its uniting with oxygen. Gold, platinum, silver, nickel, and even lead, may be reduced in the same way, and with the same evolution of oxygen gas. Several other oxides may be brought nearer the metallic state, though they cannot be completely reduced by heat, and this approach is accompanied by the escape of oxygen gas. Manganese, zinc, and probably also iron, are in this predicament.

All the oxides are reduced by means of combustible bodies, and during the combustion the combustible unites to oxygen. This is the reason that charcoal powder is so efficacious in reducing them; and if they are mixed with it, and heated in a proper vessel, furnished with a pneumatic apparatus, it will be easy to discover what passes. During the reduction a great deal of carbonic acid and carbonic oxide comes over. These, together with the metal, are equal to the weight of the oxide and the charcoal: they must, therefore, contain all the ingredients; and we know that they are composed of carbon and oxygen. Therefore, during the process the oxygen of the oxide combines with the charcoal, and the metal remains behind. In the same manner, when oxide of iron is heated sufficiently, in contact with hydrogen, the iron is reduced, and water is formed, as was first ascertained by the experiments of Dr. Priestley.

It therefore cannot be doubted, that all the metallic calces are composed of the entire metals combined with oxygen; and that calcination, like combustion, is merely the act of this combination. All metals, then, in the present state of chemistry, must be considered as simple substances; for they have never yet been decompounded.

The words *calx* and *calcination* being evidently improper, because they convey false ideas, the words *oxide* and *oxidizement*, which were invented by the French chemists, are substituted for them. A metallic *oxide* signifies a metal united with oxygen; and *oxidizement* implies the act of that union.

Metals, then, are all capable of combining with oxygen; and this combination is sometimes accompanied by combustion, and sometimes not. The new compounds formed are called *metallic oxides*, and, in some cases, *metallic acids*. Like the two last classes of bodies, they are capable of combining with different doses of oxygen, and of forming different species of oxides or acids. These were formerly distinguished from each other by their color. One of the oxides of iron, for instance, was called *black oxide*, another was termed *red oxide;* but it is now known that the same oxide is capable of assuming different colors, according to circumstances. The modes of naming them from their color, therefore, wants precision, and is apt to mislead; especially as there occur different examples of two distinct oxides of the same metal having the same color.

As it is absolutely necessary to be able to distinguish the different oxides of the same metal from each other with perfect precision, and as the present chemical nomenclature is defective in this respect, we shall adopt the nomenclature of Dr. Thomson, and distinguish them from each other by prefixing to the word *oxide* the first syllable of the Greek ordinal numerals. Thus, the *protoxide* of a metal will be employed to denote the metal combined with a minimum of oxygen, or the *first oxide* which the metal is capable of forming; *deutoxide* to denote the second oxide of a metal, or the metal combined with two doses of oxygen;* and when a metal has combined with as much oxygen as possible, the term *peroxide* will be employed to signify that the metal is thoroughly oxidized.

We shall therefore employ the term *oxide* to denote the combination of metals with oxygen in general; the terms *protoxide* and *peroxide* to denote the minimum and maximum of oxidizement; and the terms *deutoxide*, *tritoxide*, &c. to denote all the intermediate states which are capable of being formed.

Metals are capable of combining with the simple combustibles. The compounds thus formed are denoted by the simple combustible which enters into the combination, with the termination *uret* added to it. Thus, the combination of a metal with sulphur, phosphorus, or carbon, is called the *sulphuret*, *phosphuret*, or *carburet*, of the metal. The compounds formed by the metals with the three combustibles just mentioned are usually solid; but when hydrogen unites with them, it still retains the elastic state. These solutions of metals in hydrogen have been but slightly examined. They are usually distinguished by an epithet, indicating the metal, prefixed to the word hydrogen, as arsenical hydrogen.

The metals in general unite very readily with one another, and form compounds, some of which are extremely useful in the manufacture of instruments and utensils. Thus, *pewter* is a compound of lead and tin; *brass*, a compound of copper and zinc; *bell-metal*, a compound of copper and tin. These metallic compounds are called by chemists *alloys*, except when one of the combining metals is *mercury*. In that case, the compound is called an *amalgam*. Thus, the compound of mercury and gold is called the *amalgam of gold*.

* The same explanation will apply to *tritoxide* (third oxide), *tetoxide* (fourth oxide), &c. whenever they become necessary.

When no other bodies were considered as metals but those which possess ductility, and when their number was confined to six or seven, it was not necessary to seek after many properties, nor to establish any method for distinguishing and ascertaining each of these bodies. The notion of forming a classification must have scarcely occupied the attention of chemists.

At the period when the existence of a number of brittle metallic matters was ascertained, and it was admitted that all their properties approach those of the ductile metals, these began to be distinguished by the terms, semi-metals, as if ductility were the most essential character of these bodies in nature, as it is in the uses of art. Man, therefore, referring every thing to himself, and his events, gave to these bodies a determinate rank and place from their utility to himself. Another idea, less reasonable, no doubt, tended to confirm this expression of the semi-metals. The alchymists imagined that all the metals were only efforts of nature towards the production of gold, considered as the most perfect of metals, and that, by a subterraneous operation of nature, inimitable by art, they were capable of arriving at a state of maturity and perfection so as to become gold; and that all the metals were only successive states from a less to a greater degree of perfection, unto the last state, namely, aurification. Now, as ductility is one of the most prominent characters of gold, and the metals properly so called approach more or less to it by this character; those metals which did not possess it, appeared to them to be the first essays of nature, the embryos or metallic germs not yet developed. Hence, the expression of semi-metals to designate such bodies as had not undergone more than a semi-metallization.

But the slightest reflection is sufficient to show that the application of the same idea must have led to the distinction of third parts of metals, and metallic fractions, which might express the ratio or proportion of metallic properties which each of these bodies appeared comparatively to possess. This supposition shows the falsity of the expression of semi-metals, for it shows that, while it is defective as a true term of comparison to express the proportion of the metallic properties, chemistry would admit an erroneous and ridiculous language, by supposing, that the metals might in that manner pass from one to the other conversion: a conversion, which art has never been able to effect, nor can it be shown, by any observation, to have been effected in the processes of nature.

It is no less evident, that we may apply the same remarks to the words *imperfect metals*, which was adopted to denote such metals as easily lose their metallic properties, and could not be again reduced to the metallic state without the addition of some combustible substance. The same may be said of *perfect metals*, a name given to those whose calces (oxides) were reducible by the mere application of heat. This expression depends still more on the imaginary transmutation than the former term of semi-metals; since they affirm a pretended perfection in the one, and an imperfection in the other, which supposes a power of coming to perfection, and arriving at the state of the former.

Rejecting, therefore, these hypothetical terms infected with the opinions of the alchymists, and aware of the necessity of arranging the metals methodically, it became requisite that distinctions should be admitted among them, derived from properties easily appreciated, and compared with each other.

This is, however, by no means an easy task; for the relation of these bodies to the various objects of chemistry are so complex and diversified, that their classification becomes a matter of considerable difficulty; and we may safely assert, that no arrangement which has yet been made of these interesting bodies is wholly free from objection; nor do we pretend to introduce one, which has any peculiar claims to superiority, in this respect, over those that are generally received among the chemists of the present day.

The celebrated French chemist, Fourcroy, divides the metals into five orders or classes. 1. The *brittle and acidifiable*, includes four species, viz. arsenic, tungsten, molybdena, and chrome. 2. The *brittle and simply oxydizable* are seven: titanium, uranium, cobalt, nickel, (since shown by Richter not to belong to this division,) manganese, bismuth, antimony, and tellurium. 3. The metals that are *oxydizable, and imperfectly ductile*, are mercury and zinc. 4. The *ductile and easily oxydizable*, tin, lead, iron, and copper. 5. The *very ductile and difficult of oxydizement* are silver, gold, and platina.

Another still more generally followed arrangement is that of Dr. Thomson, who divides them into four classes. The first class comprehends the MALLEABLE METALS, which are the following: gold, platina, silver, mer-

cury, palladium, rhodium, iridium, osmium, copper, iron, nickel, tin, lead, and zinc. The second class includes the BRITTLE AND EASILY FUSED, viz. bismuth, antimony, tellurium, and arsenic. The third class, metals that are BRITTLE AND DIFFICULTLY FUSED: these are cobalt, manganese, chrome, molybdena, uranium, and tungsten. The fourth class are termed REFRACTORY METALS, because they have never yet been exhibited in a separate form, but always in combination with oxygen. These are titanium, columbium, tantalium, cerium, and some others.

Specification of the Patent granted to JOSEPH SAXTON, *of Sussex street, in the County of Middlesex, Mechanician, for Improvements in Propelling Carriages, and in Propelling Vessels for Inland Navigation.* Dated June 20, 1833. [From the Repertory of Patent Inventions.]

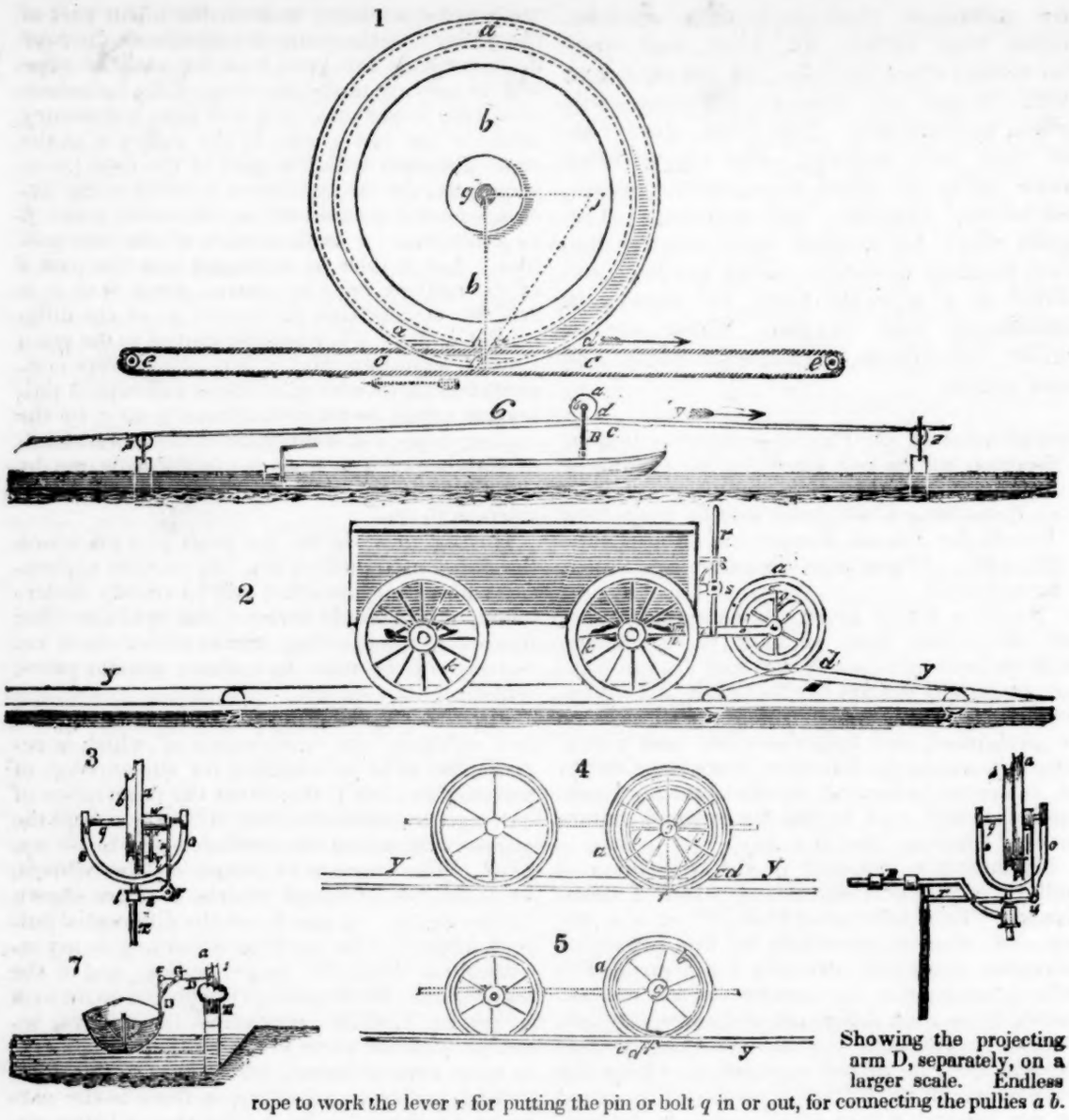
To all to whom these presents shall come, &c. &c.—*Now know ye*, that in compliance with the said proviso, I, the said Joseph Saxton, do hereby declare the nature of my invention, and the manner in which the same is to be performed, are fully described and ascertained in and by the following description thereof, reference being had to the drawing hereunto annexed, and to the figures and letters marked thereon, that is to say,

My invention consists in the application of pulleys of different diameters, which I denominate "The Differential Pulleys," or of a pulley and wheels, according to the principles hereafter described, whereby I am enabled to take advantage of the results which are obtained from such difference of diameter, by obtaining considerable velocity to carriages, or to vessels used in inland navigation, whilst the rope by which the motion is produced is caused to act through a very small space, in proportion to the distance travelled by the carriage, or by a vessel used in inland navigation, as will be fully described hereafter, when I come to describe the various figures shown in the drawing. But in order that my invention may be most fully understood, it will be desirable, in the first place, to go into a short description of the principles on which my improvements act, before I describe their application to carriages, and to vessels for inland navigation.

Fig. 1 represents a combination of two pulleys, their diameters being as six to seven, *a* being the larger pulley, and *b* the smaller one. *c d* is an endless rope, passing over the sheaves *e e*; and it should be observed, that this endless rope takes a turn around each of the pulleys, *a* and *b*; that is to say, the part *c* taking a turn around the larger pulley *a*, and the part *d* taking a turn around the smaller pulley *b*. If then the rope *d* be caused to move in the direction of the black arrow, (the upper one,) it will have a tendency to draw the lower part of the pulley *b* in the same direction with the rope *d*, meanwhile the part *c* of the endless rope will be moving in the direction of the dotted arrow, (the lower one,) and will have a tendency to move the lower part of the pulley *a* in the same direction with this part of the rope; consequently, the two pulleys *a b*, (they being fixed together,) would turn on the mean point *f*, as a fulcrum. *g* is the centre of the two pulleys. Let it then be supposed that the part *d* of the endless rope be moved from *h* to *i*, it will be evident that the centre *g*, of the differential pulleys, *a b*, would be moved to the point *j*; and, consequently, if any object were connected to the centre *g*, of these differential pulleys, it would be propelled from *g* to *j*, by the endless rope, *c d*, being moved the much smaller distance of *h* to *i*, as is clearly indicated by the dotted lines, and these distances will be as thirteen to one.

Having now shown the principles on which the differential pulleys act, the various applications hereafter described will be readily understood. And I would observe, that in all the other figures in the drawing, the same letters of reference will be used to indicate similar parts, wherever they occur.

Fig. 2 represents my improvements applied to a carriage, the construction of which is represented to be an omnibus for the carriage of passengers; but it is evident the description of carriage is immaterial, and will vary to suit the purposes to which the carriages are to be applied. The carriage is placed on four wheels, as usual, two of which wheels, *k*, *k*, are shown in this figure. *a*, and *b*, are the differential pulleys, applied to the carriage according to my invention, *a* being the larger pulley, and *b* the smaller one. These pulleys are placed on an axis *g*, see fig. 3, which represents the pulleys, together with the parts in which they are placed. *m* is an arm or frame, which carries the differential pulleys, and which is fixed to the carriage, as shown at fig. 2: the arm *m* being cylindrical, and capable of turning in bearings, *n n*, affixed to the carriage. The object of this turning of the arm *m*, is to permit the pulleys *a*, *b*, to stand at an angle, by which the endless rope may be led into the sheaves, when the carriage is going in a curved direction. The projecting arm *m* is forked at the outer end, as shown in figs. 2 and 3, at *o o*; and the forked ends serve as bearings to the axle *g*, of the differential pulleys, *a* and *b*, the pulley *a* being permanently affixed to the axle *g*, whilst the pulley *b* is capable of turning loosely on this axis, when it is not retained by the pin or bolt *q*, which locks the two pulleys, *a* and *b*, together at the times required, and thus they are at such times the same as if they were permanently attached to each other; the object of thus having the means of disconnecting the two pulleys, *a* and *b*, is, that by disconnecting them, the power will no longer tend to drive the carriage, as will be fully described hereafter. *r*, fig. 2,



Showing the projecting arm D, separately, on a larger scale. Endless rope to work the lever *r* for putting the pin or bolt *q* in or out, for connecting the pullies *a b*.

y y, endless rope—*z z*, sheaves.

is a lever, turning on a fulcrum *s*, the bearing of which fulcrum is attached to the carriage. The upper end of this lever, *r*, is formed into a handle, and is in such a position, that a person sitting in front of the carriage may have it under his control; the other end of the lever *r*, that is, the part below the fulcrum, has a crotch, which receives the flanch *t*, of a sliding-socket *t*, within it, as shown in fig. 2: this socket slides on the arm *m*, according as the lever *r* is moved out from, or drawn towards, the carriage. *u*, is a cranked or bent lever, having its fulcrum at *v*, on the forked frame *m o*, as shown in fig. 3. One end of this cranked lever *u* has a crotch, which receives the flanch *t*, of the sliding socket *t*, see fig. 3; and the other end of the bent or cranked lever *u* has also a crotch therein, by which it is enabled to slide the socket *w*, on the axis *g*, backwards and forwards. *x*, is an arm, affixed to the sliding socket *w*, through which the bolt or pin *q* passes, and this pin or bolt passes through one of the spokes of the wheel or pulley *a*; and when it protrudes beyond the pulley *a*, it passes between the spokes of the pulley *b*, and, consequently, when the pin or bolt *q* comes in contact with one of the spokes, or the part of the inner rim of the pulley *v*, which is cut away (as shown in fig. 2) for that purpose, the two pulleys will be held securely together. On the bolt *q* is placed a spiral spring, its object being, that in case the lever *r* be moved for the purpose of forcing in the bolt *q*, at a time when it is not opposite the part of the inner rim which is cut away, the spiral spring will have a tendency to force in the bolt, yet at the same time will not offer sufficient resistance to prevent the turning of the pulley, and the bolt *q* will be forced in,

when the part of the pulley where it is cut away comes opposite to the bolt; at the same time there is a spring to prevent a sudden concussion.

In fig. 2, *c d* is an endless rope, the part *c* taking a turn around the pulley *a*, and the part *d* taking a turn around the pulley *b*, as described in fig. 1. This endless rope is supported, at proper intervals of the road, on sheaves (as shown in fig. 2,) to prevent the rope falling on the ground, and thereby greatly increase the friction; this endless rope passes around a rigger at each end, by which the rope is kept sufficiently tight; but to insure the endless rope being kept sufficiently tight, I cause one of the riggers around which the rope passes to be placed in bearings capable of being slided in the direction of the length of the railway on which the carriage travels, and then, by means of weights attached to a rope or chain, and passing over a pulley affixed at the top of a well, and having sufficient weights attached to keep the endless rope, *c d*, sufficiently tight to prevent it sliding on the differential pulleys, *a b*.

Having now described the various parts shown in figs. 2 and 3, I will proceed to describe the manner of their action; in doing which, I will suppose the bolt or pin is passed through the two pulleys, *a* and *b*, and thus retains them together, as if they were permanently fixed to each other. If, then, the endless rope *d* be moved in the direction of the arrow, a similar action will take place to that described in fig. 1, that is, the carriage, being attached to the centre *g*, of the differential pulleys, *a* and *b*, will be propelled forward on a railway with a much greater velocity than the rope travels; and the distance so travelled by the carriage, in comparison with the distance through which the rope moves, will depend on the difference of the diameters of the pulleys, *a b*; and the nearer the respective diameters of the pulleys approach each other, the greater will be the relative velocity the carriage will travel, to the velocity with which the rope moves.

In order to prevent the two parts of the rope rubbing against each other, in leading on and off the differential pulleys, the axis *g* of these pulleys is placed at an angle, a little varying from a right angle with the direction of the motion of the carriage.

Figs. 4 and 5 show two applications of my improvements, but in these figures the applications somewhat vary from that shown in fig. 2; for in these instances there is only one pulley, whilst the two front or two back wheels of the carriage act the part of the other pulley.

In fig. 4, *a* is one of the front wheels of the carriage, which also acts as the larger pulley; *b* is the smaller pulley, and is the only one around which the rope, *c d*, passes. The wheels *a*, and the pulley *b*, being on the same axis *g*, which runs from side to side of the carriage, and turns in bearings affixed to the carriage.

In this arrangement, the point *f*, at which the wheels touch the rail, becomes the fulcrum on which the wheel *a* turns; and it will thus be evident, that if the rope, *c d*, be drawn forward, in the direction of the arrow, a similar effect will be produced, as described in fig. 2, and as is clearly shown by dotted lines in fig. 4; yet, at the same time, if the wheels and pulleys, *a* and *b*, be of the same relative diameters as those in fig. 2, the carriage at fig. 4 would only be propelled at the velocity of seven to one, owing to the fulcrum, at which the wheels *a* turn, being removed from the main point *f*, fig. 2, between the two diameters, and placed at the extreme end of a radiating line, drawn from the centre of the wheel *a*, to the point at which it touches the railway.

In fig. 5, the rope passes around the pulley *a*, which is larger, whilst the carriage-wheels act the part of the smaller pulley *b*. The pulley *a*, and the wheels *b*, being on the same axis *g*.

In order that the pulleys in this arrangement may stand at an angle for clearing the rope, the axle *g* is formed of three parts, connected by universal joints, and one of the wheels *b* thus travels a little forwarder than the other, and thus the rope will clear itself. And it should be observed, that in both these arrangements, the pulley around which the rope passes is to be made capable of being disconnected from revolving with the axle, as described in figs. 2 and 3. In the arrangement, fig. 5, the fulcrum *f*, on which the wheels turn, is the point at which the wheels *b* touch the rail or road; and the difference in the arrangements figs. 4 and 5, is, that the power in fig. 4 is applied by the rope between the fulcrum *f* and the centre *g*, of the wheels or pulleys, *a b*, where the weight to be drawn is attached; whilst in fig. 5, the fulcrum is between the centre of the pulley and wheels, *a b*; consequently, the arrangements differ in the order of leverage, and in this instance the velocity will be as six to one.

In these two last arrangements, the rope, *c d*, may be either an endless rope, as described in figs. 1 and 2, or the rope may be single, and taking a turn around the pulley *a*, or *b*, is to be wound on and off a drum at each end of the distance, which is to be run by one length of rope.

Having now described my improvements, as applicable to the propelling of carriages, I will proceed to describe their application to the propelling of vessels in inland navigation. This application is an arrangement similar to that shown and described in figs. 2 and 3. A representing a canal barge or boat, having an upright standard B, affixed on one side thereof, see figs. 6 and 7; at the top of this standard, the bearings, c c, are formed to receive the projecting arm D: in other respects the parts are similar to fig. 2, and the same letters are used to denote the various parts.

At proper intervals sheaves are placed on standards at the side of the canal or river, to support the rope *c d*, as shown in these figures. In propelling vessels, the same description given of figs. 1 and 2 applies, and is fully de-

scriptive of the effect which takes place by the application of my improvements.

Having now described the nature of my invention, and the manner of constructing and applying the same, I would observe, that the power to be employed for causing the rope, *c d*, to be moved, may be varied according to circumstances. Thus, for instance, by attaching a horse or horses, according to the power required, to the rope, *c d*, and causing it to move slowly, a very considerable velocity will be obtained; or the power may be derived from a fixed steam engine, or water-wheel, or manual labor. And in order to have perfect control over the carriage or vessel, and be enabled to stop at any time, although the rope is continuing to move, it will be necessary to separate the two pulleys, *a b*, by withdrawing the pin or bolt *q*; the power will then no longer act to propel the carriage or vessel, and, consequently, there will only be the momentum already obtained, by the carriage or vessel, to be overcome, and this in a carriage may be effected by aid of a brake on any of the carriage wheels, *k*.

Having now fully described the manner of applying and using my invention, I would have it understood, that I lay no claim to the parts separately of which the same is composed; and I would observe, that some of the details may be varied to meet the various circumstances to which works of this kind are at all times liable, but which will be readily arranged and adopted by any engineer competent to undertake works of the like nature. And I would further observe, that I am aware that endless ropes, as well as drag-ropes, have been before known and used for the purposes of propelling carriages and vessels, but in such cases the carriage or vessel travels only at the rate of speed with the rope; therefore, the use of an endless rope or a drag-rope forms no part of my invention, and are only necessary means for effecting the object of my invention, as above described. And I do hereby declare, that I confine my claim of "Improvements in propelling Carriages, and in propelling Vessels for Inland Navigation," to the application of the differential pulleys, or of a pulley and wheels, *a b*, for propelling carriages and vessels, as above described, whereby I am enabled to take advantage of the results which are obtained from the difference of their diameters, and thus obtaining considerable velocity to such carriages and vessels, whilst the rope by which the motion, of the carriage or vessel, is produced, is caused to act through a very small space, in proportion to the distance travelled by the carriage or vessel, as above described.

In witness whereof, &c.

Advancement of Science Abroad.—The plan of a scientific congress, which originated in Germany, and has apparently succeeded so well in England, is making its way on the continent of Europe. A meeting of men of science of France is to be held this autumn at Caen, in Normandy. The objects of its research will be the same as those of our own "British Association," with the addition of history and antiquities—two branches of science which appear at least quite as likely to benefit from *local* investigation as any other that could be named. The meeting is expected to be well attended, and the arrangements are already completed. There is likewise to be another congress, not connected with that of Caen, but composed exclusively of cultivators of geology, from all countries, at Clermont, in Auvergne. —[London Mech. Mag.]

On the Equilibration of Semi-Circular and Semi-Elliptical Arches; with an Inquiry into the Causes which have sustained, for a great number of years, some Stone Bridges, erected without regard to the true Theory of Arches. By Van De Graaff. [From the American Railroad Journal.]

It has been observed by some writers, that semi-circular or semi-elliptical arches are nearly in equilibrio when the roadway is horizontal; but this can only be admitted as true when the arch has a certain determinate thickness at the crown. As an illustration, it may be observed, that the thickness at the crown can be varied in such a manner as to cause the curve of perfect equilibrium to fall either within or without the given arch at the flanks; and there will therefore evidently exist, between those two extremes, a certain quantity of weight at the crown, which will have the best effect towards equilibrating the proposed arch: and this is the quantity which must be sought, when that curve is to be employed as an arch, for it gives the only case in which a correct view of the common analysis will indicate the ellipsis as approaching the true curve within judicious limits.

The method to be pursued in this investigation will be obvious enough, to the mathematical reader, from the hint given above, and I will therefore only show the result in the following Theorem:

In constructing, with a horizontal roadway, a semi-circular or a semi-elliptical arch, whether it be flat, as with the transverse axis horizontal, or surmounted, as with that axis vertical, I say, the most advantageous condition, *with respect to equilibrium*, will be obtained when the roadway and abutments, or piers, are so adjusted as to produce a *thickness at the crown*, including the ring and all the superincumbent matter estimated as reduced to the same specific gravity with it, *equal to one seventh part of the rise of the arch.*

The method of obtaining the most judicious ellipsis, *when a segment only is required*, has been already explained in a preceding number of this journal, but the following fact is thought by many to be a sufficient reason for disregarding the results of theory: "*Bridges which have not been equilibrated have endured for ages,*

and appear likely to endure till the materials of which they are composed crumble away." This experimental result contradicts not the mathematical principles of mechanics; for it must be remembered that such bridges, hitherto found to remain secure in consequence of the friction and adhesion of their materials, have only been subject to the action of loads passing over them at a very slow rate, in which case there was no *tremulous* motion communicated to the arch: but it is the uniform result of all experience, that friction is much reduced when the slightest *motion* takes place; and thus an arch which might stand for centuries, *if suffered to remain perfectly quiescent*, would soon tumble down from the effect of small but *repeated* jarrings, when the various parts do not mutually incline to sustain each other.

To adopt such a system of building would therefore be particularly vicious on a line of railroad, where steam is used as a moving power, for heavy locomotive engines, moving over a bridge with great speed, will communicate a *tremulous* motion to all the materials laid upon the back of the arch; and which, *although it will not be sensible in the first instance*, cannot fail, by frequent repetitions, to have a pernicious result, if the arch be not truly balanced; and as there is a probability of great advances, for many years to come, in the power and speed of locomotive engines, it is very necessary to anticipate their effect, and to construct at the present time, as far as practicable, works proper to meet such events.

The theory of arches is built upon the supposition that the superincumbent matter is possessed of gravity alone, without any adhesive quality; and that the ring of the arch is susceptible of sustaining no lateral thrust, but only capable of resisting a longitudinal compression: and these are correct suppositions, for the ring of an arch will sustain without injury a very great thrust longitudinally, but is easily broken with a lateral pressure When circular or elliptical arches are not equilibrated, the ring is continually strained at the flanks by a disposition to shove *outward;* and when this movement ever takes place, it gives room for the crown to fall in, and it is chiefly the friction, or the adhesive quality of the superincumbent matter, which prevents that effect in every instance in which such arches are not equilibrated. But when an arch is properly balanced, the experiment mentioned above is sufficient to justify a full confidence in the belief that cohesion and friction will be amply sufficient to insure stability during the small time in which a load is passing over the bridge—even when such a load *is much heavier, and moved with greater velocity*, than those which have hitherto been transported over bridges erected without regard to their equilibration.

An equilibrated arch will bear a considerable degree of *tremor* without injury; *and they only require a little more care in their construction.* The subject is one of deep interest, not only to the engineer, but to all who have money invested in such works. V. D. G.

Lexington, Ky. Oct. 1st, 1833.

Specification of the Patent granted to WILLIAM RANGER, *of Brighton, in the County of Sussex, Builder, for a Cement or Composition, which he denominates "Ranger's Artificial Stone."* Dated June 4, 1833. [From the Repertory of Patent Inventions.]

To all to whom these presents shall come, &c. &c. *Now know ye*, that in compliance with the said proviso, I, the said William Ranger, do hereby declare, that the nature of my said invention, and the manner in which the same is to be performed, are particularly described and ascertained in and by the drawing hereunto annexed and the following description thereof, that is to say:

My said cement or composition is intended, as above mentioned, to form blocks or masses of artificial stone, to be used in the construction of buildings, in place of brick or stone, or in union with either or both of them, as occasion may require; and I compose it of siliceous or other fit and proper, hard and unchangeable matters; of powdered lime in its pure or caustic state; and of water boiled or heated; and which said water I employ as hot as conveniently may be, in mixing the different ingredients. I likewise occasionally dissolve a portion, more or less, of sulphate of iron in this water, as well also as caseous and other matters, when thought desirable. I prefer to use such stone-lime as contains a portion of iron; such, for instance, as that procured in the neighborhood of Dorking, or Reigate, in the county of Surrey; also, gray-stone lime, lime from blue or yellow lias, or any other lime which is fit and proper for the purpose: and I employ it in the state of a dry powder, not slacked, as usual. The siliceous or other hard materials or matters may be such as are commonly employed; for instance, river or sea sand; skreened shingle from the seashore or beach; the two latter, however, well washed in fresh water to free them from seasalt; or I can employ broken flints, free-stone, copper slag, or other fit and proper materials of similar natures. Any, or either of these substances, as well as the lime, I separate or reduce into finer or coarser parts, either by hand, or by the employment of machinery similar to that used in making Roman cement, or any other which is fit and proper for the purpose, agreeably to the nature of the artificial stone I design to employ them to form. In general, I prefer to use them in the following proportions, videlicet,—siliceous or other hard materials or matters, thirty pounds; powdered lime, three pounds; and boiling or hot water, either containing or not the above matters in solution, one pound twelve ounces. I can, however, vary these proportions occasionally, although I have hitherto found them the best in practice. I avoid mixing more of these mate-

Fig. 1—PLAN.

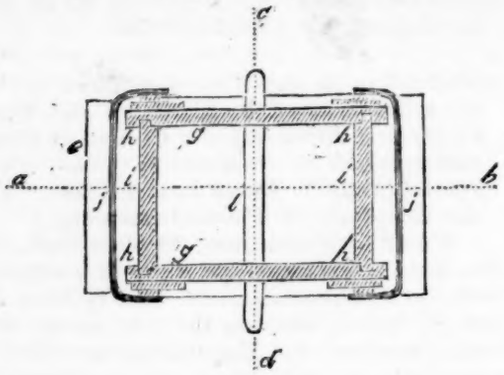


Fig. 3—ELEVATION.

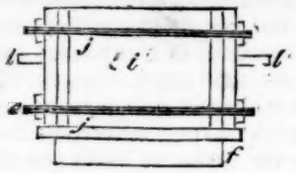


Fig. 4—SECTION THROUGH *a—b*

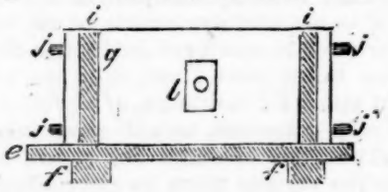


Fig. 2—SIDE ELEVATION.

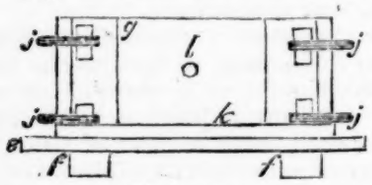
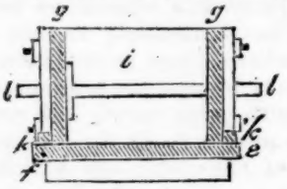


Fig. 5—SECTION THROUGH *c—d*.



rials at once than will be sufficient to fill the mould, as, owing to the heat produced by the boiling or heated water, the setting or concreting action begins to commence instantly they are put into the mould; and, in general, the mass of artificial stone becomes sufficiently firm in the course of about ten minutes, to admit of the sides and ends of the mould being removed, and the block left upon the bottom of it, ready to be taken to the place where it is to remain to dry and harden, and which will usually happen in the course of a fortnight, when the block or mass will be fit for use. I cause the materials to be carefully rammed close in all their parts, whilst filling the mould with them, in order to expel the air; and remove any excess thereof by passing a straight iron bar or scraper along the top of the mould; I can, then, likewise, when thought desirable, fill any interstices or cavities left in the face of the block, with materials of a finer consistency. The moulds will, of course, vary in their forms and manner of framing them, according to the shapes intended to be given to the masses or blocks of artificial stone; as, for instance, whether they are to be plain, or moulded in flutings, or otherwise ornamented or decorated; or whether to be square, circular, or of any other shapes; so that it is quite impossible to afford examples to any extent. As, however, it may be desirable to give some idea of their construction, I shall proceed to do so by describing the several figures contained in the drawing, which, as aforesaid, is annexed to this specification, and which represents the various parts of a wooden mould intended to form plain oblong blocks of artificial stone, each part being designated by a similar letter of reference in all the figures. *e* is the bottom of the mould, resting upon and strengthened by the two cross-pieces, *f f*. *g g* are the sides of the mould, each having two upright grooves formed in it, as shown at *h h h h*, in the plan, fig. 1, to receive and retain the ends *i i* of the mould in their proper situations. These sides and ends are held together by means of four iron bars *j j j j*, whose ends are bent at a right angle, so as to form clamps, as shown in fig. 1, between the inner ends of which said clamps and the sides of the mould wooden wedges may be tightly driven, to hold the mould together in use, and be as easily removed again when it is to be taken asunder. There are also two wooden ledges *k k* affixed upon the bottom of the mould, as shown in the end section, fig. 5, to retain the sides and ends of it steadily in their places upon it in use.

Fig. 2 is a side elevation, and fig. 3 an end elevation of the mould; and fig. 4 is a side elevation and section of it, taken at the dotted line *a b*, in fig. 1.

Fig. 5 being an end elevation and section, taken at the dotted line *c d*, in fig. 1. *l*, in all the figures, is a bar passed through holes made in the sides of the mould, to form a hole through the block of artificial stone. I prefer to place the blocks or masses of my artificial stone in the open air to harden, and even to wet them occasionally during that operation.

I do not mean, or intend hereby, to claim as my invention, the use of hot water in mixing mortar for building with; but I do hereby claim the employment of boiling or hot water in combination with dry powdered caustic lime, and siliceous or other hard matters, in the manner and in the proportions hereinbefore described, as my invention, and as essential to the forming of my said blocks or masses of artificial stone.

In witness whereof, &c.

ROADS IN ENGLAND.—The following account of the great benefits that have accrued to the English nation from their GOOD ROADS, will, we are sure, be perused with interest by every person who is anxious that internal improvements should go on prospering in this country. The great facilities that good roads afford the people of that country, for transporting rapidly their manufactures, as well as the produce of the soil, within the last few years, has had a very salutary effect in lowering the price of provisions, and enabling the merchant and manufacturer to find a ready market for their goods. The husbandman, instead of setting off to the nearest market at midnight, in his ponderous broad-wheeled waggon, travelling at the rate of two and a half miles an hour, can now, with a light caravan, travel at the rate of seven or eight miles. GOOD ROADS have also effected a very efficient reform in the Post Office department: individuals have been induced to enter into contracts, in nearly every county, to carry the mail ten miles, and in several cases twelve miles an hour. A few years since, seven miles was considered very expeditious. As a proof of the excellent state the roads are kept in, we will just mention that, about two years ago, Lord John Russell was invited to a public dinner, sixty miles from London: the dinner was about five o'clock: the speeches occupied the time until ten o'clock, and were taken down by Mr. Wood, one of the short-hand reporters to the "Morning Chronicle," and filled several columns of that paper. He transcribed every line for the compositor *on his way to London in a post-chaise.* The paper was printed in London, and dispatched by the 4 o'clock morning coaches to the very town where the entertainment had been given, and was there in sufficient time for the breakfast tables, at 9 o'clock.—[ED. MECH. MAG.]

The Great North Road in England. [From the Monthly Supplement of the Penny Magazine.]

Our island, it is true, still "stands where it did" a century ago; but in almost all other respects it is as much changed since then as an old house that had been almost wholly rebuilt. All our accommodations within "this little world" are metamorphosed since the days of our fathers and grandfathers. Turn to which side we may, where shall we find things in any thing like the same state in which they were even sixty years since? All commodities consumed, it may almost be said without exception by all classes of the people, are of improved manufacture and better quality. Look to the clothing that is now worn by men and women, even of the poorest order of our population; nearly every article of it is of a quality such as formerly was not generally used, even by the most opulent. The same thing is true of their food. Throughout England, at least, inferior substitutes for bread made of wheaten flour are now nearly every where discarded; the people will live upon nothing, or at least will take nothing for the main basis of their subsistence, except that best and costliest of all the generally cultivated productions of the earth. Other articles of consumption, again, such as tea, for example, and sugar, have, from being the luxuries of the few, become almost universal necessaries. The houses inhabited by persons of every degree are equally changed and improved. So is every article of furniture, every thing intended either for use or ornament, which they contain. It would be an endless task to attempt to enumerate the many things which but a generation ago were rare, and are now possessed, in greater or small measure, almost by every body; the many other things that were then hardly ever seen, and are now common and plentiful everywhere; and the many others still that absolutely did not exist then, and are now enjoyed either by the whole community or by a large portion of it.

But that which lies at the root and beginning of all these things, and is indeed the foundation of a country's civilization, is a system of good roads. Without this the national resources and energies remain, in nearly their sum total, unawakened and useless. Roads are the veins and arteries by means of which the circulation of the social body is carried on. Where they do not exist, there can hardly be said to be a community. The people have nothing in common. They are not one people in any thing but the name. No commerce, nor intercourse of any kind, mixes them up together into one mass. The inhabitants of a country entirely without roads would, of necessity, be savages.

No country on the face of the earth is so well provided with roads as our own; and that is one of the chief of the causes which places this country, beyond all rational dispute, at the head of the civilization of the world. The greater part of England is now intersected in all directions, not only by paths by which persons may pass on foot from one place to another, but by broad highways for the movement of wheel carriages, and the transference of the heaviest loads that can be dragged by the power of horse or of machinery. Formerly vehicles drawn along the public roads were not allowed to carry above a very small weight. In 1629, Charles I. issued a proclamation commanding that no common carrier, or other person whatsoever, should travel with any wain, cart, or carriage, with more than two wheels, nor with a load of above twenty hundred weight, for fear of injuring the roads; and no

nalties continued to be exacted under this regulation for many years after. Our present roads, as compared with those which then existed, are not more multiplied than they are improved in quality. Of their number and extent, the latest complete account which has appeared is that given in the appendix to the report of a Select Committee of the House of Commons, which sat on the subject of turnpike roads and highways in 1820. From this document it appears that the length of all the paved streets and turnpikes in England and Wales was then 17,725 miles, and that of other public highways 95,104 miles, making the total length of travelling road 114,829 miles. Assuming all the turnpike roads to be of the statutable breadth of 60 feet, and the others on an average 30 feet broad, the space covered by the whole would be not less than 482,000 acres, or about 752 square miles. In the years 1812, 1813, and 1814, (the latest for which there are any returns,) this extent of road was kept in repair at an annual expense of £1,404,842, being at the rate of £12 6s. 8d. per mile. But notwithstanding all that has already been done in this way, the business of opening additional lines of road is constantly going forward. Some idea of the rate at which this species of improvement proceeds may be gathered from the fact, that in the six years from 1827 to 1832 inclusive, the number of acts of parliament which were passed for the formation of new, and the repair or alteration of old roads, amounted to 388, or nearly 65 on an average per annum.

If the whole surface streaked and cut into by these roads, and our other channels of communication, could be taken in by the eye at once, what an extraordinary display of national enterprize and national wealth it would present! So large an accumulation of the conquests of energy and the constituent elements of riches, it may be safely said, was never before collected within the same compass. These roads are often the noblest exemplifications of art subjugating and triumphing over the opposition of natural difficulties. Many of them are carried through the air over considerable rivers, by bridges of more or less cost and magnificence. Others are supported across depths and hollows on stupendous embankments. Some are driven under ground through mountains. Some terminate in piers that extend far into the sea. There is no hostile force that their daring engineers have not faced and vanquished. And then to our common highways are to be added our railroads, and canals, and rivers made navigable, or otherwise improved by art, as all entering into the aggregate of those channels of communication which our ancestors and ourselves have created, and which contribute in so eminent a degree to make England what it is.

The advantages, however, which we thus enjoy are, in by far the greater part, only of comparatively recent acquisition. The Baron Dupin, in the introduction to his work on the "Commercial Power of Great Britain," writing in 1822, remarks, that fifty years before that time France was generally as far ahead of this country in all that concerns public utility, as we had since got before his own countrymen. Imperfectly supplied with roads as France now is, compared with England, the Baron's statement is probably true, if confined even to this particular. If we turn back at least to times somewhat, though not very much, more remote, we find that there were hardly any roads on which travelling could be conveniently performed, except in the immediate vicinity of the capital, and not even always there. In the appendix to the "Results of Machinery," a passage is quoted from an historical work, according to which it appears that Prince George of Denmark, having in December, 1703, to make the journey from Windsor to Petworth, was 14 hours in accomplishing that distance of forty miles in his coach, the last nine miles having taken six hours to get over them. "We did not get out of the coaches," says the narrator, one of the Prince's attendants, ("save only when we were overturned, or stuck fast, in the mire,) till we arrived at our journey's end. . . . We were thrown but once, indeed, in going, but our coach, which was the leading one, and his highness's body coach, would have suffered very much, if the nimble boors of Sussex had not frequently poised it or supported it with their shoulders." In those days, indeed, and long after, the common mode of travelling was on horseback; and in country parts, goods were almost universally conveyed on pack-horses. We gave, in our 61st number, a relation, extracted from Dr. Cleland's "Statistical Account of Glasgow," of a journey made in this manner by two inhabitants of that city to London, in the year 1739, in which it is stated that they found no turnpike road until they came to Grantham, in Lincolnshire, 110 miles from the English metropolis. Up to that point they had to make their way along a narrow path, raised in the middle of an unmade soft road, into which latter they had to descend whenever they met one of the gangs of packhorses carrying goods, the raised causeway not being broad enough to allow the two parties to pass each other. "We, who in this age are accustomed to roll along our hard and even roads at the rate of eight or nine miles an hour," says a writer in the Quarterly Review, (xxxi. 356,) with much truth, "can hardly imagine the inconveniences which beset our great grandfathers when they had to undertake a journey—forcing their way through deep miry lanes; fording swollen rivers; obliged to halt for days together, when the 'waters were out;' and then crawling along at a pace of two or three miles an hour, in constant fear of being set in some deep quagmire, of being overturned, breaking down, or swept away by a sudden inundation."

The Romans formed several excellent roads in Britain, as they did in every other country which they subjected to their arms: but the

ages of confusion and misery that followed their departure from the island obliterated these, with nearly every other vestige of their domination. For a long period, instead of our roads being improved, they probably continued to grow worse and worse. About the time of the Norman Conquest, the principal streets of London appear to have been little better than ditches or marshes. It is related that in the year 1090, on occasion of a storm of wind blowing down the roof of St. Mary-le-Bow church, in Cheapside, four of the rafters, each twenty-six feet long, were pitched so deep into the street that scarcely four feet of them remained above ground. Holborn* was not paved till the beginning of the fifteenth century. In the year 1417, the king, Henry V, ordered two vessels, each of twenty tons burden, to be employed at his expense in bringing stones for this purpose, by reason that the highway in question was so deep and miry, that many perils and hazards were thereby occasioned, both to the king's carriages passing that way, and to those of his subjects. The western end of Holborn, however, appears not to have been paved till 1541, in which year both it, Gray's Inn lane, Chancery lane, and other streets now in the heart of the city, are described as "very foul and full of pits and sloughs, very perilous and noisome, as well for the king's subjects on horseback as on foot, and with carriages."

The first notice which has been discovered of the collection of a toll for the repair of roads in England occurs in the year 1346, in the reign of Edward III. In that year it was ordered that tolls should be exacted for two years to come, from all carriages passing along Holborn, Gray's Inn lane, and the highway called Charing, "which roads," says the commission, "are, by the frequent passage of carts, wains, and horses, to and from London, become so miry and deep as to be almost impassable."

As for the country roads, little or no attention seems to have been paid to them till towards the middle of the sixteenth century. In the course of the reign of Henry VIII. four statutes connected with this subject were passed: two for altering certain roads in the Weald of Kent, and in Sussex, a third for mending a lane near the city of Chester, and a fourth for the repair of bridges. The first general act for keeping the roads in repair was passed in 1555, in the reign of Mary. It imposed that duty upon the parishes, and was followed by many others to the same effect in the reigns of Elizabeth and James I. The first toll-bar was erected in 1663, on the northern road leading through Hertfordshire, Cambridgeshire, and Huntingdonshire: "which road," says the act, "was then become very bad, by means of the great loads of barley, malt, &c. brought weekly to Ware in waggons and carts, and from thence conveyed by water to London." Three toll-gates were erected, one for each of the above-named counties; and it is said that the people were so prejudiced against the innovation, that they rose in a mob and destroyed them.

Coaches are said to have been first introduced into England in 1580, by the Earl of Arundel, and by the commencement of the next century they had become common in London. They were brought to Edinburgh in the suite of the English ambassador in 1598. The historians of that city tell us, that coaches for the use of the public generally were established there in 1610. Hackney coaches were first introduced in London in 1625.

As yet there was but little intercourse between these two capitals. In London, Scotland and Edinburgh were considered as foreign parts. In 1635 a proclamation was issued by Charles I. to the effect, that, "whereas to this time there hath been no certain intercourse between the kingdoms of England and Scotland, his majesty now commands his postmaster of England for foreign parts to settle a running post or two, to run night and day between Edinburgh and London." It was a considerable time after the commencement of the last century before there was more than one despatch of letters in the week from London to Scotland. In the year 1763, the London coach set off from Edinburgh only once in the month, and was from 12 to 16 days on the road. The vehicle which accomplished this adventurous achievement was at that time the only stage-coach in the northern capital, except two which ran to the neighboring port of Leith. A journey to or from Edinburgh was in those days a doubtful and hazardous expedition—something like setting out in quest of the north-west passage. It is said that, in Scotland, when a person determined upon attempting the achievement, he used, with the laudable prudence of that country, to make his will before setting out.

The change that has since taken place is immense. The journey between London and Edinburgh is now performed by the mail-coach, at all seasons and in all weathers, in little more than forty-three hours and a half. The person who undertakes it exposes himself to scarcely any more danger than he does when he walks along the street in which he lives. Even in Scotland, a man seldom now thinks of making his will merely because he is about to visit London. These changes, and the countless others of which they are examples or indications, are due to the existence of a good road between the two capitals. This road, more than the compact of the year 1707, is the true union of the kingdoms.

Within the last thirty years this Great North Road, as it is commonly called, has been extended to the remotest extremity of the island—to a point still farther beyond Edinburgh (at least by the line taken) than Edinburgh is distant from London. This latter portion especially, and also parts of that extending to the

* A long street in the centre of the metropolis.

south of Edinburgh, have recently undergone some material alterations and improvements. Those that have been effected within the last three years alone are well fitted to raise the admiration of all who are qualified to appreciate their importance. They afford an evidence which is extremely gratifying, of the exertions that continue to be made in order to uphold and extend one of the chief foundations of our national prosperity and greatness. We have been fortunate enough to obtain very complete accounts of the principal of these improvements, in most instances, from persons having access to the best sources of information; and abstracts of these we now propose to lay before our readers, interspersed with such explanations as may convey a full and correct view of the whole course of this great highway,—the longest continued line of road in the United Kingdom. [*To be continued.*]

MACHINE FOR CUTTING GRAIN.—[The Union, a paper published at Lexington, Vir., gives the subjoined account of an 'important invention.' We should like to have further particulars from Mr. McCormick—the price, &c.—and, if convenient, a drawing.]

We have omitted until now to furnish our agricultural friends with an account of a machine for cutting grain, invented by one of our ingenious and respectable county-men, Mr. Cyrus H. McCormick, and which we witnessed in operation in a field of grain during the late harvest in the neighborhood of this place. A large crowd of citizens were present at the trial of it, and although the machine (it being the first) was not as perfectly made as the plan is susceptible of, yet we believe it gave general satisfaction. We have been furnished with some certificates from several of our intelligent farmers, one of which we have appended to the following description of the invention.

This machine is so constructed as to leave a long or a short stubble, to operate alike well on tall or short grain. It is drawn by one horse walking by the side of the grain in shafts—just behind is a wheel about 2 feet 3 inches in diameter, which runs on the ground, by which the machinery is operated—having a cog-wheel with 40 cogs screwed to it. There is a small wheel (with 9 cogs) working in that, having another on the same shaft with 28, which works another small one, turning a small crank, behind the wheel, and from this crank the knife receives a vibratory motion. It is about 4½ feet long, with an edge somewhat like that of a sickle, (having teeth,) straight and projecting into the grain at right angles to the horse. Behind the knife is an apron 5 or 6 feet long, of thin plank: and this frame connects with and is made fast to the frame which supports the main wheel—having a slide, or small wheel, under it, to support it, say about 5 feet from the main wheel. Alongside the apron, by the point of the knife, and extending some distance before the knife, is raised a partition of cloth, for the purpose of dividing and keeping separate the cut grain from that which is left standing. Then is a reel, as it is termed, which is about 6 or 7 feet in diameter, and the same length of the knife. This is made by framing arms in each end of a shaft, say 8, the points of which are joined together by pieces, called ribs, parallel to the shafts. The reel is revolved as the machine advances, by a band from the main wheel to one on its shaft, the object of which is to draw the grain back to the knife, which will be done whether straight or tangled, upright or leaning, unless below an angle of 45 deg., and to throw it on the apron. When a sufficient quantity shall have been collected for a sheaf, the hand who attends it draws it off the apron with a rake. The grain is prevented from slipping with the edge of the knife by pieces of wire projecting before it within 1 or 2 inches of each other.

"July 18, 1833.

"I certify that Mr. C. H. McCormick's Reaping Machine, with a horse, was employed by me in the late harvest, and though I did not work it much, I was satisfied with its work. I tried it for an hour, and calculated what it would do for a day, and found that it would cut in a day about 12 acres. I done so more than once. The present year was unfavorable for the trial, as the wheat was lodged in the field. I was so satisfied that I bought one. This preparation was necessary: the ground must be clean—free from stumps and large stones.

"JAMES MCDOWELL."

Effects of Burying Iron and Steel in the Earth. By JUNIUS REDIVIVUS. [From the London Mechanics' Magazine.]

SIR,—Some of the principal physical agents in the furtherance of human happiness being metals, and, amongst those metals, iron taking the foremost place, I was much gratified by reading your extract from the *Chronicles of Old London Bridge*, which seems to open some new views as to the further improvement of our national manufacture. But there is some obscurity in the statement of the circumstances, which it would be well to have cleared up, if possible, for the advantage of the experimentalists who may be inclined to trace the matter up to its causes, since 'this effect effective must come by cause.'

It seems that the burying of either steel or iron in the earth, for either 'three years,' or 'six or seven hundred years,' causes a decided improvement in its quality. Of what nature the improvement was, in the case of the razors which were buried, we are left in ignorance; but it seems that the change must have been wrought by an operation of natural chemistry, either taking something from the metal, or adding something to it, or both, by the process of chemical affinity. I should be led to imagine that

both circumstances had taken place, as it is stated that, though a coat of rust had gathered on the razors, they were not eroded: that is, had sustained no loss of substance. The process would then be perfectly analogous to what is called the petrifying of wood, or other organized substances, wherein, as the organized matter decays, a deposit of lime assumes the same form. To get at the complete facts, we ought to know—first, the chemical analysis of the razor blades when first buried—secondly, the analysis of the 'earth' in which they were buried—thirdly, the analysis of the razor blades when they were again dug up—and, fourthly, wherein the improvement consisted, or what new qualities were acquired by the steel. Mr. Weiss would render a great service to science and art by stating these particulars as far as his experience enables him,—if, indeed, it were not interfering with his profits as a manufacturer, to make his secret known. This no man can be called upon to do, unless for specific remuneration. But I take it for granted, that the author of the *Chronicles* states the *facts*, and that they are not of a piece with the proposition of the gardeners, that 'melon seeds should be worn some years in the breeches pocket previous to planting.'

In the case of the pile-shoes of London Bridge, which were of iron, a change took place in the straps which were in contact with the charred timber, and not in the solid points. This is a different case from the steel which was buried in the 'earth;' yet both the iron and the razor blades were *improved*, though the circumstances were different. A supposition is given, that, in the case of the iron, the change was wrought by galvanism. Very possibly; but it would be for the interest of manufacturers and the public to know it more certainly. 'Improvement,' and 'earth,' are far from definite terms, and a variety of chemical distinctions may be comprised in them. The object sought for is to effect, by the chemistry of art, in a short space of time, that which takes the chemistry of nature 'three years,' or 'some six or seven hundred years,' to accomplish. Are there yet data enough to work by? If not, they should be sought; and by careful inquiry and experiment, that would be made a matter of common knowledge which is at present a matter of uncertainty.* I have understood that your correspondent, Mr. Rutter, is one of the favored few possessing the rare combination of pecuniary means with public spirit. Surely the experiments I have endeavored to indicate offer a worthy field for the exercise of his talents. Yours, &c. JUNIUS REDIVIVUS.

March 18, 1833.

* In almost all our metallic manufactures, mechanism is in advance of chemistry. The latter science has never yet been properly pursued as a whole, by an united body of men, but is indebted for its progress to the energy of individuals, who have from time to time devoted themselves to it, principally at their own cost, and the public at large have benefitted by their 'labors of love.'

Ballingall's Improvements in Ship-Building.

[From the London Mechanics' Magazine.]

SIR,—In the Mechanics' Magazine for April there is a notice of a plan and book published by me, on improving the construction of merchant shipping, for which I thank you. There is, however, one mistake in it, which I must take leave to correct. I undoubtedly most cordially approve of the plan and effects of doubling vessels' bottoms and sides, *outside*, as recommended by Mr. Snodgrass. The expense of that method, however, hinders it from being generally adopted, especially as the present classification of merchant shipping in Britain takes away every inducement to lay out any expense which can possibly be avoided, on a vessel which is of, or nearly of, the first class. Now, the last sentence of the last paragraph of the notice, immediately before the quotation from the *Scotsman*, implies that this method has been practised in the Kirkcaldy smacks, Enterprize and Fifeshire. This is not the case, and is the mistake which I think it right to correct. The inside or ceiling planking of these vessels only is made completely watertight, on the plan described in the "Mercantile Navy Improved;" and the whole expense of fitting each of the smacks, including all outlay, was under £30. The effect has been as correctly described in the quotation from the *Scotsman*. This trifling expense, therefore, cannot hinder any ship-owner, who wishes to preserve his vessel, and to save insurance on her and cargo, and also to get a preference to his vessel in consequence of additional safety, when seeking a cargo, from adopting it. I may also observe, that there is an erroneous position given to part of the letters of reference in fig. 2, which is apt to produce a misconception of the mode of construction I recommend. In fig. 2, S S are merely supporters to the bilge-piece, and not water-courses; for, by the method proposed, the fabric is solid, and all water-courses would be inside the vessel.

I embrace this opportunity of sending you some documents on the prevention of shipwreck, in the hope that you will lend your aid to impress the facts which they contain on the attention of the public, and I am, sir, your most obedient servant,

JAMES BALLINGALL,
Surveyor of Shipping at Kirkcaldy.

Kirkcaldy, April 4, 1833.

The documents alluded to by Mr. Ballingall, at the close of his letter, derive a pecu-

liar interest at the present moment, from the dreadful losses which have been caused at sea by the awful storms of last month. No less than 59 merchant ships were reported at Lloyd's as having been wrecked in two days, not including (we believe) the Erin steamer, which it is now certain must have sunk, with every soul on board. *Not one King's ship, however, was lost.* Now, it is probable, that had those merchant vessels been built on the plan of filling in the timbers which Sir Robert Seppings introduced into the Royal Navy, and Mr. Ballingall is now exerting himself so strenuously and patriotically to introduce, along with other improvements, into the merchant service, there is reason to believe that the greater part of them might have been saved. A correspondent of the last number of the *United Service Journal*, in describing the gale of the 20th of March, says: "It came on by a sudden shift of wind at about 3 A. M., and instantly blew a furious hurricane, driving on shore and upsetting coasting vessels, dismasting large ships, unroofing houses, tearing up mighty oaks, whirling the waves like a boiling cauldron, and spreading ravage in all directions. A noble East Indiaman and some other vessels *were shivered to splinters* upon the rocky coast near Fishguard and Ramsey Sound: every soul perished." But who can wonder that they should be "shivered to splinters," when probably not one of them had a casing of more than three inches thick, and some only 1½ inch; while a man-of-war has a solid bottom of 15 inches thick? Is it stupidity, economy, villainy, or what, that causes this wanton exposure of life and property? Perhaps the following extract from one of the papers which Mr. Ballingall has handed to us may serve to furnish an explanation. It is part of a report made by a committee of merchants, shipowners, and underwriters, on the classification of ships, presented to a general meeting held at the City of London Tavern, as far back as the 1st of June, 1826, and conceived in the following terms:

"And can it then be contended, in the very face of conclusive evidence, proving that property *and life* are continually sacrificed to the negligence and cupidity of those who, from ignorance or hope of fraudulent gain, construct insufficient ships, or neglect to maintain them in a state of secure efficiency, that the public is entitled to no protection, lest control should interfere with the rights of property, or that *that can be private right which directly produces public wrong?*

"Your committee are persuaded it is unnecessary to enlarge on this topic, and that, whatever may be the opinion entertained with respect to the specific propositions submitted by them, the necessity for *some* provision against the dangers arising from ignorance, negligence, and fraud, will be generally admitted."

To this extract there is appended the following note (by Mr. Ballingall, we presume):

"*No measures are yet in practice to remedy this crying evil*, and property *and life* are every day sacrificed to the negligence and cupidity of those who, from ignorance or hope of fraudulent gain, construct insufficient ships, or neglect to maintain them in a state of secure efficiency; and unless the public send forth its irresistible voice, there is every reason to apprehend that the practice of building insufficient ships, or maintaining them in a state of secure efficiency, will never be remedied, and *public wrong* will continue to be perpetrated, arising from ignorance, negligence, and fraud, and terminating in the most melancholy and fatal results to property *and LIFE.*"

The sum of the matter seems to be briefly this: Ship-builders and insurance-brokers thrive upon shipwrecks; and, therefore, all other interests must be sacrificed to theirs! Talk of the savage wreckers on some parts of our coasts: the men who purposely make ships, and encourage the making of ships, so that they may be wrecked *with every possible facility*, are ten times more savage, more inhuman, more diabolical.

Since we took notice of Mr. Ballingall's scheme for the reform of this disgraceful state of things, it has been under the consideration of the Society of Arts for Scotland; and we are glad to perceive that they have pronounced an opinion of its merits entirely in conformity with our own. On the sixth of February last, a report from a committee appointed to investigate the subject, was "read and approved of by the Society," in which the committee state that "after an attentive examination of his plans, and after a personal inspection, by some of their number, of a vessel, in the construction of which his principles had been applied, they are unanimously of opinion that the general adoption of the system recommended by Mr. Ballingall would be of the greatest service to the country; as, although the expense of the construction of vessels would,

in some degree, be increased, yet their greater durability, and the security of their cargoes against partial damage, would more than compensate the additional outlay." Among the names subscribed to this report are those of Admiral Sir David Milne, one of the most experienced officers of the Navy, and John Robison, Esq. the able and intelligent Secretary of the Royal Society of Scotland.

Of the Orders of Architecture. [Continued from page 150.]

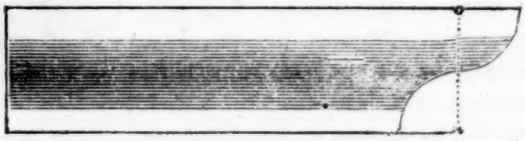
MOULDINGS.—Mouldings are those parts which project beyond the face of a wall, a column, &c. and are employed as ornaments in most Architectural operations.

The regular mouldings are eight in number, and are represented by the following figures.

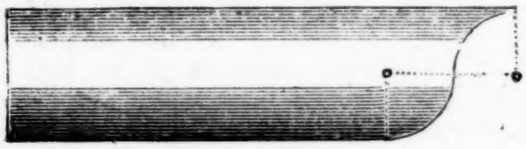
Annular List, or Square.

Astragal, or Bead.

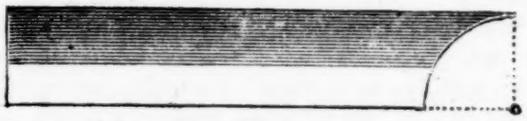
Cima Reversa, or Ogee.



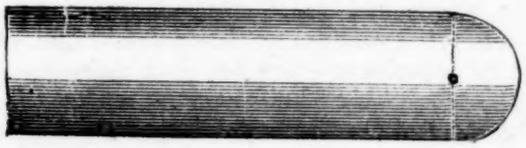
Cima Recta.



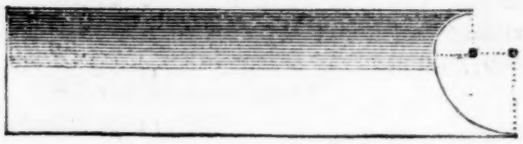
Cavetto, or Hollow.



Ovolo, or Quarter Round



Scotia.



Torus.

The forms of all mouldings are referred to a section at right angles to their longitudinal direction, when prismatic, or passing through the axis, if annular; and this is simply denominated the *section*, on account of its frequent use, as oblique sections only occur in mitres. The names of mouldings depend upon their form and situation.

If the section is a semicircle which projects from a vertical diameter, the moulding is called an Astragal, Bead, or Torus; if a torus and bead be both employed in the same order of architecture, they are only distinguished by the bead being the smallest. The tori are generally employed in bases and capitals.

If the moulding be convex, and its section be the quarter of a circle or less, and if the one extremity project beyond the other equal to its height, and the projecting side be more remote from the eye than the other, it is termed a Quarter-Round; this, in Roman architecture, is always employed above the level of the eye.

If the section of a moulding be concave, but in all other respects the same as the last, it is denominated a Cavetto. They are never employed in bases or capitals, but frequently in entablatures.

If the section of a moulding is partly concave and partly straight, and if the straight part be vertical and a tangent to the concave part, and if the concavity be equal or less than the quadrant of a circle, the moulding is denominated an Apophyge, Scape, Spring, or Conge: it is used in the Ionic and Corinthian orders for joining the bottom of the shaft to the base, as well as to connect the top of the fillet with the shaft under the astragal.

If the section be one part concave and the other convex, and so joined that they may have the same tangent, the moulding is named a Cymatium; but Vitruvius calls all crowning or upper members cymatiums, whether they resemble the one now described or not.

If the upper projecting part of the cymatium be a concave, it is called a Cima recta; they are generally the crowning members of cornices, but are seldom found in other situations.

If the upper projecting part of the cyma-

tium be convex, it is called a cima reversa, and is the smallest in any composition of mouldings, its office being to separate the larger members: it is seldom used as a crowning member of cornices, but is frequently employed with a small fillet over it, as the upper member of architraves, capitals, and imposts.

If the section of the moulding be the two sides of right angles, the one vertical, and the other of course horizontal, it is termed a *fillet*, *band*, or *corona*. A fillet is the smallest rectangular member in any composition of mouldings. Its altitude is generally equal to its projection; its purpose is to separate two principal members, and it is used in all situations under such circumstances. The corona is the principal member of a cornice. The beam or facia is a principal member in an architrave as to height, but its projection is not more than that of a fillet.

Tar from Pit Coal, a Cheap Substitute for Paint, for the Roofs of Houses. By F. H. [From the Farmers' Register.]

I applied to a painter in Richmond last summer to furnish me a bill of paints, &c. for a small building then erecting, who advised me to use what he called coal pit tar, for the roof, instead of paint. I have followed his advice, and am very much pleased with the result. The color produced from the tar is a beautiful glossy dark slate. Time only can determine whether it will be lasting; but I see no reason to doubt it. The tar is obtained from the pit coal in its process of distillation for the production of gas. It cost me in Richmond $5 50 per barrel of 33 gallons. In Baltimore, where it is manufactured, the cost would probably be much less. F. H.

Frederickshall, Louisa,
Sept. 20, 1833.

Precautions against Fire—Improvements suggested. By William Reed. [From the London Mechanics' Magazine.]

Sir,—I would beg to impress on architects and builders of new houses, the propriety of introducing stone staircases. The difference in cost would not be much in the long run, perhaps nothing at all, while the additional security to life and property would be immense. In all large houses with two staircases, the back stairs ought at all events to be of stone; but even in the third or fourth rate class of houses I do not see why stone should not be employed. Supposing a ground floor to be 12 feet in height, that will require a stair of 20 steps, of about three feet in width, which will only take up a space of 6 feet by 12; and, for the sake of commodiousness, there may be a landing at the tenth step, half way up, all as shown in the following rough sketches, of which fig. 1 is a side elevation, fig. 2 an end view, and fig. 3 a plan.

Fig. 1

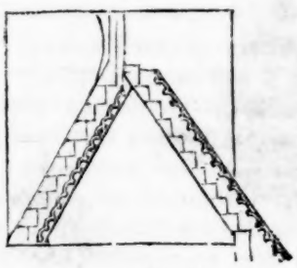


Fig. 2

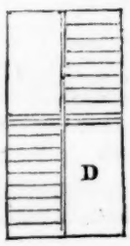
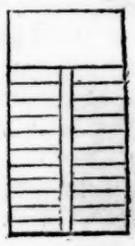


Fig. 3



The width of three feet will, I conclude, be quite sufficient for the removal of such articles of furniture as are in common use among the inmates of such houses. By building the stair in two divisions, those hateful triangular steps, called winders, which have caused many a serious fall, would be got rid of. D will be the thoroughfare or door. The stone stairs may have bars of iron under them for their better support, as I have seen here in many instances. They should, of course, have wrought iron balustrades.

Another suggestion I have to offer relates to fire plugs. When it is dark or the streets are muddy, or a crowd has collected on the spot before the engines arrive, there is generally a good deal of difficulty in finding the plugs, and much time lost in consequence. I would therefore propose that, exactly opposite to every fire plug, there should be a lamp, with a glass of pink color, so that the driver of a fire engine might drive up to the very spot without the delay of a single instant. The cost of such a lamp would be so trifling that I dare say that the fire companies would themselves defray it.

Your obedient servant,
William Reed.

Peterhoff, Jan. 10, 1833.

The Undulating Railway. By JUNIUS REDIVIVUS. [From the London Mechanics' Magazine.]

SIR,—Your correspondents, Messrs. Badnall and Cheverton, have fallen on me tooth and nail, on the subject of my letter respecting the *undulating railway*, but neither of them seems to have accurately read the letter in question, and consequently without taking into consideration the fact of the very bare data on which I wrote, they pleasantly enough assume that I ought to have taken another ground of attack. All that I knew of the railway was from a casual hearing that there had appeared a paragraph in the 'omnium gatherum' of the 'leading Journal,' stating that an undulating railway had been invented, whose effect would be utterly to destroy all level railways by its superior utility. The *Athenæum* I have not seen. Feeling interested in the matter, I caused inquiries to be made at the Adelaide Gallery, but, lo! the carriage had disappeared, and the inventor had retired to 'Brummagem.' Inquiry was made for a prospectus, and reference was given to Messrs. Sherwood, Gilbert, and Piper. Application was made to that firm, and the reply was, that nothing was known of it. Now, what inference could be drawn under these circumstances, but that the whole thing was a gull? I therefore assumed that the object of the undulating railway was to increase power or diminish friction, in short, to make a given amount of power do more work. Upon this assumption I reasoned, and I have reason to know that the reasoning was to the satisfaction of many persons besides myself, though Messrs. Badnall and Cheverton are not satisfied. I certainly do not purpose entering into the abstruse calculations the former gentleman adverts to in his two questions, and for which I have neither leisure nor inclination. I shall only state generally, that even supposing the total amount of friction to be the same on the curve and on the level, the accumulation of friction which will take place upon one-half of the ascent, will rack, and rapidly destroy, either the engine or horses from which the power may be obtained. Neither shall I attempt to calculate the difference of the velocity on the curve and on the horizontal line, but content myself with remarking, that it is only by an increase of power that an increase of speed can be obtained. Does Mr. Badnall purpose using fixed engines on the summit levels to draw the carriages up the ascending curves? Before he puts upon me the onus of setting forth his fallacy, it would be but fair that he should give your readers an opportunity of knowing what it is that he really proposes to do, and wherein the advantage consists of the undulating surface over the level. I have taken some pains to acquire the information, but have not succeeded. You have been in the same predicament, and have evidently drawn the same conclusions as myself. Mr. Badnall seems sore with me: I regret it; I did not wish to hurt his feelings. I spoke of the railway, not with reference to persons, but to things. And my incredulity may certainly be excused, when it is considered that want of sufficient explanation, on the part of Mr. Badnall, has left me as well as others in the dark. I really should not be the last to hail with joy such a triumph of mind over matter as Mr. B. proposes, but I should like first to see it fairly made out beyond dispute.

Mr. Cheverton begins his letter by deprecating any intention of giving offence. It was needless—I am but a shadow, and as void of taking, as of intentionally giving offence, having no object in putting forth my ideas, such as they are, save the eliciting of truth, by which result I as well as others may hope to benefit. I say to all, strike and spare not, and, whenever culpable, I will bow to the chastening rod. Had I been an offence-taker, Mr. C. has certainly hit upon the best mode of provoking it. He calls me a 'clever writer.' I had rather he called me a fool, since the latter may be an honest man, whereas the former commonly means a man who can argue like the 'lawyer' Mr. C. alludes to, on any side of a question, without caring for the truth. I may be an 'unpractised thinker,' of which allegation I leave your readers to judge, but I assuredly am not 'a writer,' in the literary meaning of the term; and as for cleverness, I should be sorry to have it proven upon me, as being the direct opposite to either wisdom or honesty.

With regard to the general effect of the railway in question, Mr. C. seems to hold the same incredulity as myself, though he would seem to know something more of the details than I do. How he came by his knowledge I cannot divine, inasmuch as he says, specifically, 'I cannot enter upon this point, as I have not investigated nor even seen the experiments.' Taking this

acknowledgment into consideration, he would seem to speak with over confidence as to the '*facts*' of the experiments. I will not say, with his friend the engineer, that 'though I should see it I would not believe it,' but were I to see it, I should be suspicious of a trick in the first instance, and in the next, when satisfied that the thing was actually a fact, I should be disposed to think that the age of miracles had returned, and that the laws of nature were in one especial instance subverted. Mr. C. would seem to be rather 'superficial,' in expecting me to reason without data; and that I had no more data than yourself to go upon, I have already set forth. I could not set forth a fallacy. which had not been presented to me for examination.

With regard to the scheme of locomotion from summit to summit, by means of the pendulum, I shall not reason upon it as a mathematical proposition, but as a practical matter. A carriage, say of one ton weight, exclusive of wheels and axles, will require a certain power to draw it along a given level. This carriage would be upon four axles of the smallest diameter consistent with security. If it were taken off the four axles, and slung upon one axle, it would be found in practice that the single axle would require to possess four times the strength of each of the four, and the friction upon the increased diameter would consequently be in the same proportion. More than this, the suspending bars would be no slight addition to the total weight, and something extra must be allowed to the single axle on that acconnt. Therefore, taking into consideration the friction of the axle, slow though the motion be round the axle, the resistance of the air, the power required to move the carriage along the 'short roads,' the hanging and unhanging, the increased distance between the curve and the level, and the extra weight, I should say at once that the process would be less economical than that of the four-wheeled carriage on the level. There is no need of mathematical calculation to come to this result, and I cannot conceive the use of propounding abstruse mathematical calculation in a matter which, it is self-evident, can turn to no useful account. Mr. Cheverton will not set about pendulum locomotion in earnest, when he takes into consideration the expense of the lofty pillars required for the points of suspension, for the world is not yet ridged up into equal distances like a ploughed field. As for 'the proposition that all hindrance is provided against,' it is nothing more than a proposition that all friction shall be voted a bore; but so long as the bore continues to exist, so long will the pendulum locomotion remain an unprofitable speculation. When it shall be overcome, the only difficulty will be to chain up locomotive machines, to prevent them from doing damage by the exercise of their ruling passion—to move. Mr. C. asks me to show 'how and where the diminution of friction at any place or places along the curve would be compensated by an excess of friction in others.' The exact 'where,' I shall not attempt to show; that it is so, I will endeavor to illustrate in a familiar manner. Let Mr. C. take a common carpenter's saw from the mould-loft, and screw it in a vice with the edge uppermost, parallel to the horizon; then let him traverse a roller along it in both directions, and he will find that the amount of friction will be considerably more from point to heel than from heel to point. The reason of this probably is, though I do not pronounce confidently, that the elasticity, both of the roller and the saw, exerts a greater force to overcome the friction in the latter case than in the former. The opposing points, in the former case, deaden the elasticity, and leave the friction to exert its whole force. Now, in running a carriage down hill, there is a very considerable quantity of elasticity brought into play; in some cases the friction is nearly all removed by the carriage actually bounding in the air, a fact which, as I have before remarked, caused, as I have been informed, the application of steel springs to coal-waggons. But after the carriage has descended with the velocity increased by the elasticity, it serves to impinge it with the greater force against the opposing points of the ascending curve, and the momentum is accordingly expended more rapidly than it was accumulated. As the ascent increases the friction increases also, and it is aided by the centre of gravity increasing its distance *behind* the point of contact. To state the matter shortly, the carriage runs down hill because the centre of gravity is *before* the points of contact; it will not run up hill, because the centre of gravity is *behind* the point of contact; and the elasticity which aids the downward momentum is absorbed on the ascent, in a ratio quicker than that of its generation, while no fresh elasticity can be generated, for the carriage in its ascent adheres closely to the track on

which it moves. How Mr. Badnall purposes to apply his moving power I know not, but I apprehend that a steam-engine is not by any means improved by going at a very irregular pace; going down hill, scarcely any power would be needed—going up hill, an enormous power would be needed; and that horses are not the better for being unequally worked was sufficiently proved by the fact of the large expenditure of capital on the Highgate Archway.

Mr. Cheverton thinks it marvellous that carriage-builders should not be aware of the fact, that 'a plate of iron was stiffer placed on its edge than when flat.' Whether they are aware of the fact or not I do not pretend to pronounce. That it *is* a fact that some of them use their plates in an unscientific manner, he cannot doubt, when two of the guild, 'Phæton,' and 'A Carriage-maker,' have held differing opinions on it in the pages of your Magazine. Mr. C. is witty on my proposition to ballast carriages as ships are ballasted, yet wherein it is ridiculous I am at a loss to divine. He would scarcely propose to save weight in the use of the ship, by omitting the ballast altogether. This would be like the ape in the story, who

> 'To try conclusions, in the basket crept,
> And broke his own neck down.'

In the case of the carriage, the proposition was not the saving of weight, but the adjustment of the springs to the necessary tension for either one or more persons, and solely with a view to the greatest comfort of the riders. If it were merely desired to save weight, the springs should have been altogether omitted. If it be desired to procure the most perfect state of elasticity, conducing to the comfort of the riders, I should feel obliged if Mr. C. would point out any better mode than the one I have proposed. The better to illustrate what he has conceived the absurdity of my proposition, Mr. C. has introduced the story of the Spanish mule; but it has proved a failure, and has served to evidence two things against himself: first, that he has not studied the philosophy of mule loading; and, next, that he is guilty of the 'unpractised thinking' with which he charges me. Had the spirit of Mr. C. ever inhabited the body of a mule, after the fashion of the transmigration doctrine, or had he served any time as an *arriero*, he would know that the most essential thing to the orderly travelling of a loaded mule is, that the cargo should be as nearly equal in *weight* and *bulk* as possible, on either side the pack-saddle. A good mule will carry four hundred pounds weight, two hundred on a side Now, were two hundred and fifty placed on one side and two hundred on the other, and the mule could speak, like Balaam's ass, he or she would say to Mr. Cheverton, supposing him to be the muleteer, 'Be so good as either to take away the odd fifty from my right side, or if that cannot be done, as the next best thing, add another fifty to the left side, because the heat of the pack-saddle and the cloths beneath it has stewed my hide almost to a jelly, and the unequal strain across my back-bone will burst it when the cargo begins to jolt.' Now, with an inanimate cargo there is sometimes a chance of reduction; but as Mr. C. laughs at the muleteer's plan in the case of the live cargo, he is bound to show what better plan he would have adopted, or forfeit his reputation as an engineer skilled in resources. Would he have eschewed the 'load of stones,' and then have gravely purposed to pare away the superfluous weight from the biggest traveller, after the Procrustean recipe? I suspect that the Andalusian knife, or the four-square blade of the *matador*, would have been brought forward in arrest of judgment. There is a saying amongst the mountain muleteers of some parts of Southern America, *La mula sabe raciocinar mejor que algunos Christianos*—(The mule knows how to reason better than some Christians.)

With regard to the repeating air-gun I proposed, Mr. C. has taken 'an incomplete and superficial view' of my letter. If he reads it again, he may discover that there was no proposition therein to 'multiply power by complication,' but simply the substitution of compressed air, which would not destroy the gun, instead of the steam and intense fire which does destroy the gun. The power is to be communicated to the air by means of the steam, because the steam itself cannot well be applied. *Voila tout!* Really Mr. C. would seem to be an 'unpractised thinker.' Ere he so triumphantly quoted my words, to the intent of my 'mere confusion,' as *Cloten* says in the play, it surely would have been but a very small portion of wisdom to endeavor to understand the tendency of the air-gun letter, notwithstanding the obscurity of my mode of writing.

Mr. C., at the conclusion of his letter, again hopes that his 'observations will be taken in good part.' They are so, and replied to in the same spirit, and I have to thank him in addition for having thus given me an opportunity to explain myself more fully.

I am, sir, yours, &c.

JUNIUS REDIVIVUS.

April 22, 1833.

---

*Mr. Badnall's Treatise on Railway Improvements, and in particular the Undulating Railway.** [From the London Mechanics' Magazine.]

The principal subject of the treatise before us is introduced by a preliminary exposition of the advantages of railway conveyance, and an examination of the obstacles to their immediate general establishment. Among these obstacles, the "difficulty of ascending inclined planes by locomotive power" occupies a foremost place. The employment of "stationary engines," or "locomotive engines with cog-wheels," to overcome this difficulty, is briefly adverted to, but justly pronounced to be attended "with serious if not insuperable inconveniences." Mr. Badnall's attention having been "particularly directed" to the discovery of some better remedy, the idea at length occurred to him that a sufficient power might be gained by the descent of a body down one inclined plane, to compensate for the opposition from gravity in ascending another; and if so, that a railway uniformly constructed in such an up and down, or undulating plan, might be economically substituted for the partly horizontal and partly inclined railways at present in use.

"The improvement occurred to me on the 7th of June, 1832. The impressions on my mind, before the trial of any experiments, were, that by an undulating railway a greater resistance would be opposed to the power of steam, or any other locomotive power, than upon a level railway; but that much would be gained by the power of gravity, multiplied by active power, down a descent; and that, consequently, a locomotive engine of any given power would travel at a greater speed, or drag a greater weight, than upon a horizontal railway. I was also of opinion that the increased resistance or fulcrum, offered by the descending part of each curve, and the advantage gained by the power of gravity multiplied by active power, would be sufficiently great to render locomotive engines more effective than they have at present proved to be upon inclined planes."—p. 31.

Mr. Badnall, after some explanatory remarks on the subject of friction and gravity, proceeds to describe the different experiments which have, in his opinion, fully established the soundness of these his preconceived opinions. Some of the more striking of these we shall here lay before our readers.

"I ordered a small engine to be manufactured, on clock-work principles, with a strong spring in a barrel, and a fusee sufficiently large to admit of travelling the length of 50 or 60 feet, being also particularly anxious that the power of the spring should be sufficient to overcome the pressure of the engine wheels on the plane, when kept from progressing. Wishing to try these experiments as privately as possible, during the time which the manufacture of the engine occupied, I was engaged at Douglass, in the Isle of Man, in superintending the making of two railways, the one curved, the other horizontal. These were each 32 feet in length (the length of the most spacious room I could find unoccupied); the length of the ascent and descent of each curve, or undulation, was *one foot*, and the height and depth of each curve from the centre was half an inch, or one inch from the summit of the convex to the base of the concave of the curve. I had also ordered a small carriage to be made, to be attached to the engine, when necessary, and to run upon four wheels of the same diameter as the wheels of the engine.

"On the 23d July I received the engine and carriage from Liverpool; their weights were as follows—Weight of engine, 9 lbs. 6 oz.: weight of carriage, 3 lbs. 10 oz.: diameter of wheels, 3 inches: width of the periphery of the wheels, $\frac{3}{8}$ of an inch.

"On trying the strength of the spring, I was sorry to observe that it was not sufficient, when I placed the carriage on a smooth surface and prevented its progression, to turn the wheels; that is, it had not power, as I wished it to have, to overcome the adhesion, or friction, between the wheels of the carriage and the surface of the plane.

---

* A Treatise on Railway Improvements, explanatory of the chief Difficulties and Inconveniences which at present attend the General Adoption of Railways, and the means by which these objections may be overcome; as proved by a Series of Interesting Experiments, &c. By RICHARD BADNALL, Esq. 142 pp. 8vo. Sherwood & Co.

"I, however, resolved to try a series of experiments with it, and afterwards to return it to Liverpool, to have a stronger spring attached to it. Accordingly, I had the railways placed firmly down, and upon as exact a level as circumstances would permit. The distance between the lines on each railway was 8 inches; the width at the surface of the rails was half an inch; the distance between the wheels of the engine governed, of course, the width between the lines; and care was taken to give the carriages sufficient play, to prevent them being bound by friction against the sides of the rails.

"Having ascertained that both railways were level, the spring was wound up, by drawing the engine backwards from the end of the line to the commencement. It was started without any weight attached, and the following was the result: Curved railway, 6 sec.; horizontal, 7 sec.

"I then placed 7 lbs. weight upon the engine itself, which had a platform for such purpose: the result was, curved railway, 8 sec.; horizontal, 9 sec.

"I then attached the small carriage to the engine, and, without load, I found the speed of travelling along either line was in the same proportion as before.

"I then tried various weights in the carriage, and invariably found a decided advantage in the curved railway. This advantage was, however, more evident in the following experiments: With 17 lbs. weight in the carriage, from north to south, curved railway, 15½ sec.; horizontal, 20½ sec. From south to north, curved railway, 17 sec.; horizontal, 22½ sec.

"Now, omitting the half-seconds, and taking the averages, the difference of space which the engine would have travelled over on the curve, in the time required to travel 32 feet on the horizontal plane, is as follows—16 : 32 : : 21 : 42 feet; shewing a difference of nearly one-third in the speed.

"Thinking it probable that, by the variation in the time occupied in traversing the lines from different sides of the room, that they might not be perfectly level, I had them again examined and adjusted with particular caution; after which, on again trying with the same weight, viz. 17 lbs., the result was as follows: From north to south, and south to north, on the curve, 16 sec.; on the level, 22 sec.

"This last experiment was repeatedly tried, and without any distinct variation; the time was ascertained by a second-hand watch, and carefully noted by Mr. J. L. Gardener, of Manchester, who also witnessed the experiments.

"Although I perceived that 17 lbs. was as great a weight as the engine could well convey upon the horizontal railway, I was anxious to try the result of greater, and increased the load to 22 lbs. The result was, from north to south, on the curve, 17 sec.; on the horizontal line, 30 sec. From south to north, on the curve, 18 sec.; on the horizontal, 28 sec.

"It was here quite obvious, that the curve produced a far more decided advantage; and this advantage was evident at starting; as, on the horizontal road, the engine moved very slowly at first, and traversed 12 or 13 feet before it attained its average speed, whereas, upon the curved line, its motion was apparently regular throughout.

"Although these experiments were in every point of view so satisfactory in regard to speed, I was surprized to find that the advantage was not so great as I anticipated in regard to the difference of load the engine was capable of dragging on the two lines. I, however, clearly proved that we could convey a much greater weight upon the curve line than upon the plane; for when the engine would not move at all upon the horizontal road, it would travel without difficulty upon the curve; and it is extraordinary, that in conveying any weight from 15 lbs. upwards on the latter, the time occupied in doing so varied in a very trifling degree.

"The same comparative results took place upon an inclined plane of 1 in 144."

A second undulating railway having been constructed, with a curve of five feet ascent and descent, and two inches in depth, and some alterations having been made in the engine, which made it both stronger and lighter, the following additional experiments were made:

	Number of Seconds.		
	Horiz. pl.	1 ft curv.	5 ft curv.
Engine alone, weighing 9 lbs. 4 oz. and the hind and fore wheels 5-16 inches apart, - - -	5	4	3¼
Do. and carriage, weighing together 12 lbs. 14 oz. - - -	5½	4½	4
Do. with 5 lbs. in carriage, -	6¾	5½	4½
Do. with 10 do. do. - -	8½	6½	5½
Do. with 15 do. do. - -	9¾	7	6
Do. with 20 do. do. - -	13¼	8¾	7¼
Do. with 25 do. do. - -	18	11	9
Do. with 30 do. do. -	30 scarcely could go	14	11
Do. with 35 do. do. -	could not go	18	12
Do. with 40 do. do. -	- - - -		13
Do. with 45 do. do. -	- - - -		15

After repeatedly trying these experiments, and always obtaining the same results, Mr. Badnall had another railway constructed with *short* ascents and *long* descents:

"The length of each descent being 8 feet; the length of each ascent 2 feet; and the whole line being thirty-two feet. It consisted of three descents and three ascents, and a platform of one foot at each extremity, the tops of which were on an exact level with the summits of each ascent; the depth of descent at the lowest point being two inches from the highest rise, as in the railway whose curves were five feet. It is necessary to remark, that the descents in this railway, except about a foot from their lowest points, were regular inclined planes, curving off at the bottom, to render the ascents more regular, which ascents were also curved."

The following table exhibits the results of this modification of the undulating principle:

	Number of Seconds.						
	On the perfect level.				Inclination 1 in 42⅔.		
	Horizontal plane.	5 ft curve.	Long and short curv.	Weights.	Horizontal plane.	5 ft curve.	Long and short curv.
Engine alone	5	3¼	4		6¾	5¼	5¼
Do. & carriage	5¼	4	5	lbs.	7¼	6	6
Do. with 5 lbs.	6¾	4¼	6	1	8¼	6¾	6¼
Do. 10 "	8¼	5¼	7	2	9¼	7	7
Do. 15 "	9¾	6	7¼	3	11	7¾	7¼
Do. 20 "	13¼	7¼	8	4	12	8¼	7¾
Do. 25 "	18	9	8¼	5	13¾	8¾	8
Do. 30 "	33	11	9	6	16¾	9¼	8¼
Do. 35 "	–	12	10	7	22	10	9¼
Do. 40 "	–	13	11	8	30	12	9¼
Do. 45 "	–	15	12	9	–	14	10¼
Do. 56 "	–	–	14	10	–	–	11
Do. 58 "	–	–	14¼	11	–	–	12
Do. 59 "	–	–	14¾	12	–	–	13
Do. 60 "	gr't difficulty		16	13	–	–	15¼
				13¼	–	–	16

Mr. Badnall states, that on trying the engine on this long and short curved railway, *the reverse way*, that is, by causing it to descend the short curve first, "the result was found to be the same."

It was observed in the course of the preceding experiments, that when heavy loads were passed over the railways, a considerable degree of vibration was occasioned. To get rid of this possible source of error, the different railways were next nailed firmly down upon three inch planks, and the following experiments made in the presence of Mr. Gill, of Manchester, one of the directors of the contemplated Manchester and Leeds Railway.

On a perfect level:

	Number of Seconds.		
	Horizontal plane.	5 ft curve, rise 1 in.	Irregular curve, rise 2 in.
Engine and carriage, without load,	5¼	4¾	4¾
Do. do. with 5 lbs.	6¾	6	6
Do. do. 10 "	8¼	6¾	6¼
Do. do. 15 "	9⅝	7¼	7¼
Do. do. 20 "	11¼	8¼	7¾
Do. do. 25 "	13½	9¼	8¼
Do. do. 30 "	15¼	0	9
Do. do. 32½ "	18¼	10¼	9¼
Do. do. 35 "	20	11	10¼
Do. do. 37½ "	21¼	11¼	10¼
Do. do. 40 "	23¼	12	10¾
Do. do. 42½ "	29	12¼	12
Do. do. 45 "	–	13¼	12¼
Do. do. 50 "	–	16	12¼
Do. do. 55 "	–	19	17

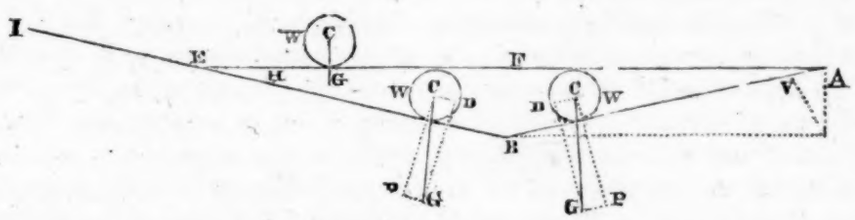
Up an inclination of 1 in 96:

Engine and carriage, without load,	5¼	4¾	4¾
Do. do with 2½ lbs.	6¼	5¼	5¼
Do. do. 5 "	7¼	6	6
Do. do. 7½ "	8¼	6¼	6¼
Do. do 10 "	9	7¼	7
Do. do. 12½ "	11	8	7¼
Do. do. 15 "	12¼	8¾	8
Do. do. 17½ "	14	9¼	9
Do. do. 20 "	15¾	11	10¼
Do. do. 22½ "	19	12	11
Do. do. 24 "	27	12¾	12
Do. do. 25 "	would not go	13	13
Do. do. 27½ "	–	16¼	16
Do. do. 29 "	–	18¾	17

It will be observed, that the degree of speed on all the railways is much greater in these experiments than in any of those before recited. Mr. B. accounts for this by stating, that "the cord upon the spring-barrel having broken, he was compelled to re-attach it, and regulate the power of the spring accordingly." Another circumstance that will strike the reader is, that, in the experiments before made, 30 lbs. was the utmost load which could be conveyed on the horizontal railway, while in the last set of experiments 42½ lbs. were conveyed. This difference Mr. B. attributes partly "to the renewed strength of the spring," and partly "to the freedom from vibration," obtained by making fast the railways to the three inch planks. A still more remarkable discrepancy, however, is that exhibited by the two curved railways in regard to speed, in the different sets of experiments. In the first trial, for example, made with the long and short curved railway on a level, the rates of speed with all weights under 20 lbs. were less, by 1" and 1½", than on the five feet curved railway; while in the last quoted experiments there was scarcely any perceptible difference. In the case of all weights, again, above 20 lbs., the advantage was, in the former expe-

riments, on the side of the long and short curve railway, to the extent in some instances of 3″, while in the latter the advantage rarely exceeded 1″, and in some instances only half a second. Mr. Badnall admits that these differences are not so susceptible as the others of explanation. "I confess myself in difficulty, and can only account for it by the difference in the vibration of the two railways, or some inaccuracy in levelling, especially as the depth of each curve was similar."

Be the difference, however, as it may, between the two sorts of curved railways, Mr. B. thinks he is entitled to rest satisfied with the fact, that they have both, "whether upon the level or inclines, invariably proved an unquestionable and decided superiority over the horizontal railway." He estimates this superiority as being equal to a saving of one half in point of time, and a gain of twice the power in respect of weight. His theoretical explanation of the advantage thus gained is as follows:



"Suppose the line E A to be a horizontal railway,—A B to be a descending one,—and B E an ascending one, on which are placed the three wheels, W W W.

"1. Now, the amount of friction produced by the pressure of the wheel W on the plane E A, is in exact proportion to its weight, or to the weight of any vehicle which rests upon it; and upon such weight also depends the amount of attrition produced by the revolution of the axle within the nave or cylinder in which it moves.

"The reason why the amount of friction, or attrition, is proportionate to the weight of the vehicle, is because (supposing C to be the axle or centre of the wheel) the perpendicular line C G is the line of gravity.

"On a horizontal railway, therefore, the amount of pressure upon the rails, and the amount of axle and rolling friction produced by that pressure, are in exact accordance with, and altogether dependent upon, the weight of the carriages and load; and when locomotive power is employed to overcome this pressure and friction, and when a maximum velocity is attained, such velocity (the power being kept up) is uniform through spaces and times, and such pressure or friction is an *uniformly opposing power*. Moreover, as before frequently observed, the amount of load which any locomotive engine will convey in exact accordance with the amount of its pressure upon the rails and axles; or, in other words, with the axle and rolling friction.

"2. Let us now suppose the wheel W to be traversing from A to B. From the point A, it is evident that a body would fall to T, according to the laws of bodies falling perpendicularly; and if upon the line A B we draw the perpendicular line V T, a body would descend by gravity down the plane from A to V, in the same time as it would fall, perpendicularly, from A to T; and the power of gravity, which enables it to do this, acting *equally* (practically speaking) throughout the whole descent from A to B, would produce *an uniformly accelerated motion;* in consequence of which, on the arrival of the carriage at the point B, the velocity would (allowing for the difference of friction) be mathematically equal to what it would be at the point T, had it fallen perpendicularly from A to that point. Now, the extent of the power of gravity, or cause of the wheel W descending down the incline A B, will be easily comprehended by reference to the parallelogram D C P G: where the diagonal, C G, is the line of gravity, C P the line representing the amount of pressure on the rail, and C D the line of motion; that is, the line or power of gravity, C G, instead of acting perpendicularly, and with full intensity, on the rail, as on the line E A, becomes divided into two separate and distinct powers, viz. C D and C P; the latter, if I may so express myself, endeavoring to stop the progress of the wheel, and the former employing every effort to urge it forward; and as C D is to C P, so is the one power exactly to the other—and thus, if the

carriage or wheel W weigh five tons, and if C D be one-fifth of the power or force, C P, the pressure upon the rails is reduced from five tons to four tons; and *not only reduced*, but the amount of power thus saved is actively employed in opposing the resistance offered by C P.

"Such would be the *commencement* of the progress of a carriage descending the incline A B by its own gravity, until, as before observed, on arriving at B, it would attain the same velocity as it would have attained at T, had it fallen perpendicularly from A to T; and if locomotive power were constantly employed to assist this force of gravity, the progress of a body down the descent would be the result of these united powers; the motion would be *uniformly accelerated*, and although the velocity would be increased in proportion to the increased power employed, yet the descent would be in proportionate accordance with the laws of falling bodies, both as to spaces and times.

"3. But we will now suppose the same carriage, W, to be propelled from a state of rest at B, to the position on the incline B E, described in the diagram. The angle F E B being equal to the angle F A B, and the line of gravity, C G, being drawn, the parallelogram C D G P is exactly equal to that described on the descending plane; consequently, C P is the line representing the amount of pressure on the rails, and C D the line of power opposing such pressure; from which it is evident that, unless prevented by some greater power than C D, the carriage would roll back to B, but if opposed by any regular and greater power, which we will call locomotive power, the carriage would rise gradually up the plane B E, with uniform velocity, and through equal spaces in equal times; for the power C D, which is a portion of the force of gravity represented by C G, *being opposed by a greater power* than itself, does not in this case act as *an uniformly retarding power*, but as *an uniformly opposing power*. It will also be seen that, throughout the ascent, the pressure upon the rails, and, consequently, the amount of friction, is precisely the same as it was down the descent A B, viz. as much less than it was on the horizontal E A, as the line C D to D G.

"4. But to prove the advantage to be derived by an undulating railway, we must not allow the carriage to stop at B; we will therefore suppose it to travel as far as it is able, by gravity alone, along the undulated line A B E.

"Now, as before observed, it would descend from A to B, according to the laws of falling bodies, at which point it will have attained its greatest speed, and, consequently, its greatest momentum, and it is evident that it will rise the ascent B E, as long as the force of momentum is greater than the force C D; but the instant such force of momentum, which in this case is *an uniform retarding force*, becomes less than the force C D, the latter would effectually operate, and the carriage W would roll back, and finally settle at the point B.

"Supposing, however, that the momentum gained by the descent to B be sufficient to advance the carriage as far up the ascent as the point H,—it is evident that, could sufficient power be *then* employed to overcome C D, the ascent H E would be made in much less time, with fewer revolutions of the wheels and axles, and with much less expense of power, than it would require to move up the whole ascent B E, as stated in position 3.

"We will now suppose that an assistant power, equal to the available power C D, be employed to propel the carriage W along the undulation A B E, and that such power were withdrawn at the point B,—it becomes evident that, as *gravity alone* enabled the carriage to rise the ascent as far as H, which is more than one-half of the whole ascent, now that double power is employed, double momentum at the point B will be the result; and the power C D will thus effectually be opposed up the whole ascent B E. If this be true, how much more effectually will the power C D be counteracted if the assistant power be continued up the whole ascent B E!

"From this reasoning, it appears to me indisputable, as decidedly proved by experiment, that not only can a given load be conveyed along a curved line in *very much less time* than upon a horizontal plane, or *a very much greater weight* in the same time, but that loads which no locomotive power could move on the horizontal plane E A, would, impelled by gravity, assisted by other active power, descend down A B, and rise the ascent B E with facility; and it will be also evident, that whatever power may be left on arriving at the point E, will be the power of ascending the further incline E I; to which surplus must of course be added the continued active power employed to oppose C D.

"5. It must be remarked, that although the disposable *power* of gravity in opposition to

pressure is only as C D to C P, yet this is no criterion of the extent of advantage gained in speed; in fact, C D may as properly be stated to represent the saving in friction. In whatever light, however, it may be viewed, C D represents a *constant* and *equal* power throughout the whole descent; but the spaces passed over down that descent, in consequence of such power, are *not* equal in equal times, but, owing to accelerated velocity, as the squares of the times. Supposing, for instance, A V to be 10 yards, and the carriage was one second in reaching V, and allow the same space to be travelled over on the horizontal plane in the same time, at maximum velocity,—now, on the latter, the carriage would travel 30 yards in 3 seconds; but down A B it would travel 90 yards in 3 seconds; because $3 \times 3 \times 10 = 90$; and this velocity, although retarding up the ascent, if assisted by an equal power to that employed on the horizontal plane, would be so kept up as to arrive at a given distance in far less time than it could be done with an average load on the horizontal plane. Supposing, for instance, the horizontal line E A were 175 yards long, the descent A B 90 yards, and the ascent B E 90 yards, making the undulating line 180 yards, and that locomotive power were employed sufficient to overcome the friction and the resistance of the atmosphere on both lines, and to move a carriage along E A at maximum velocity, 10 yards per second, it is obvious that the time required to travel from E to A would be seventeen and a half seconds, because $\frac{175}{10} = 17\frac{1}{2}$.

"Let us now apply the same power to the same carriage travelling along the undulation A B E, and take 10 yards as the space travelled over in the first second down the descent A B, it is obvious that it would reach the point B, or, in other words, traverse the 90 yards represented by A B, in 3 seconds; because, according to the laws of descending bodies, $3 \times 3 \times 10 = 90$. This being admitted, and even presuming that the power employed upon the ascending part of the undulation were *only just* sufficient to *overcome* the friction and resistance of the atmosphere, the carriage would naturally, as proved by the action of the pendulum, rise the ascent B E in the precise time it occupied in traversing from A to B. Hence, if a given power be employed, sufficient to overcome the friction and resistance of the atmosphere, and to impel a load 10 yards in the first second, upon an undulating line, such as A B E, 180 yards in length, the whole distance, if the power be constantly kept up, will be traversed in *less* than six seconds; whereas, if a given power be employed sufficient to overcome the friction and resistance of atmosphere, and to impel a load 10 yards in the first second of time, *at maximum velocity*, upon a horizontal line, such as E A, 175 yards in length, the whole distance cannot be traversed in less time than $17\frac{1}{2}$ seconds. Thus, if we ascertain the maximum velocity at which a body can be impelled upon a horizontal line *in the first* second, and down the descending part of a given curve in the first second, such power being sufficient to overcome friction in both cases, the comparative time occupied in traversing each distance is easily determinable: the difference in advantage varying in proportion to the length and depth of undulation, as compared with the length of the horizontal line. Nor must it be overlooked, in considering this subject, that a much greater load can be conveyed along an undulating line than along a horizontal one. The axle and rolling friction to be overcome is necessarily less upon the former than upon the latter, and the fulcrum presented to the effective power of steam, down the descending part of each undulation, is a most important object of advantage. It will be seen, that in this explanation I have calculated the velocity of a body traversing a curve, according to the laws which would govern its descent down a regular inclined plane; there would of course be some difference, but in this instance it cannot be material to describe it."

In an appendix to the treatise, two letters are given from *Mr. Robert Stephenson, senior,* to Mr. Badnall, in which *Mr. S. fully admits the superiority of the undulating railway over the horizontal one*, and is at some pains to account for it on practical grounds. He concludes with expressing an opinion, that it "will require even a longer railway than the Liverpool and Manchester one, to prove the extent of its value."

Dry Rot.—No. IX of the London Quarterly Review contains an excellent article on this subject. The application of corrosive sublimate to the wood is found to be a preventive, and, consequently, adds greatly to the durability of timber.

The Marquis of Blandford's Apiary, on Mr. Nutt's System. [From the London Mechanics' Magazine.]

Sir,—From the interest which you have uniformly taken in whatever relates to the extension of Mr. Nutt's invaluable system of bee management, (see page 174 of Vol. I. of this work,) I am induced to forward to your notice a detail of the successful results of that system, in the hands of the Marquis of Blandford, at Delabere Park, near Reading.

His lordship's park is most delightfully situated, about a mile from the romantic and retired village of Pangebourne, in Berkshire. The choice of the situation for the apiary is most excellent and delightful. It is at the top of a tower, forty-six feet high, situated in the midst of a wood, and commanding a most extensive view of the surrounding country, including a great part of Berkshire, Oxfordshire, Wiltshire, and Hampshire, the face of nature being clad in its endless variety of fertility, and old father Thames gently meandering through the valley formed by the distant hills which close the scene, but affording few prospective traces of those immense physical developements of his powers which render him truly the monarch of rivers. On the top of this tower his lordship possesses four colonies in collateral hives, and one inverted hive, all of which have been started since April. In the collateral hives the labors of the bees have been highly successful. From one colony his lordship has already separated a box containing 30 lbs. of honey, whilst another box, along with three small glasses, which cannot contain together less than 40 lbs., are quite ready for taking, and which will afford the sum of 70 lbs., and this without infringing upon the stock necessary for their winter subsistence. Upon my examination, the thermometer in the end boxes did not exceed 70°, whilst exposed to the atmosphere it was at 64°. A most remarkable contrast was afforded by the superior quality of the honey contained in the end box over that in the "pavilion of nature;" this superiority, particularly in the coloring matter, was most evident. Mr. Smith, the intelligent keeper, who quite follows in the steps of Mr. Nutt, informed me that the average quantity of honey produced from a cottage hive, upon the old system of management, did not exceed 30 lbs. to 40 lbs., whilst only in one case did he obtain, from a hive enlarged by eking, the amount of 50 lbs. It is extremely satisfactory and fortunate that, for the sake of reference, Mr. Nutt's system has fallen into such good hands, as both his lordship and the keeper appear to be as devoted to the system as they have been happy in the results.

I am not able to speak much regarding the progress of the inverted hives, of which his lordship has two—the one being at the top of the tower, and the other on the lawn at the back of the house—the former containing twenty-three glasses, and the latter thirty-three: this last is really a magnificent construction, an ornamental garden appendage such as few noblemen can boast. The bees had in each filled all the intermediate parts betwixt the hives and the glasses, and were just commencing their labors in the latter. Next summer his lordship will, I anticipate, reap an extensive harvest, both from these as well as his collateral hives, which are getting into prime and excellent condition for the winter.

I have troubled you with these details, because they relate to facts, and a publication of such facts is all that is required to introduce this admirable system of bee management into universal introduction. Let the example but be extended, and the practice inculcated, amongst our rural population, and, whilst it will greatly conduce to their advantage, we need no longer look to France or Italy for a supply of treasures which our own country and peasantry could so efficiently produce.

I am, sir, your obedient servant,

Abraham Booth.

Reading, July 22, 1833.

[In no country is there more facility afforded for the introduction of some such plan as in this, and the great interest many of our readers have expressed on the subject, induces us to insert another article from one of the best periodicals of the present day.—Ed. M. M.]

Description of an Improved Bee-Hive. By Mr. William Todd, Kirkmaiden. [From the Quarterly Journal of Agriculture.]

Mr. Todd, having, for some years past, made the management of bees a subject of study, has paid particular regard to the various kinds of hives, and the modes adopted for separating the bees from a part of their work, without injury to the remainder of the bees or their combs; and after trying various sorts of hives, has found none that he

would compare with the one which is the subject of this paper. It is now four years since this hive was brought to its present improved state, and the experience of that prolonged trial has served to convince him more and more that it is all that can be desired, for the two purposes of *dividing swarms* and the *abstraction of honey without killing the bees*. Mr. Todd believes that the plan is hitherto confined to himself and two or three others in his neighborhood, but is desirous that its advantages should be made known.

The annexed cuts, figs. 1 and 2, exhibit

Fig. 1.

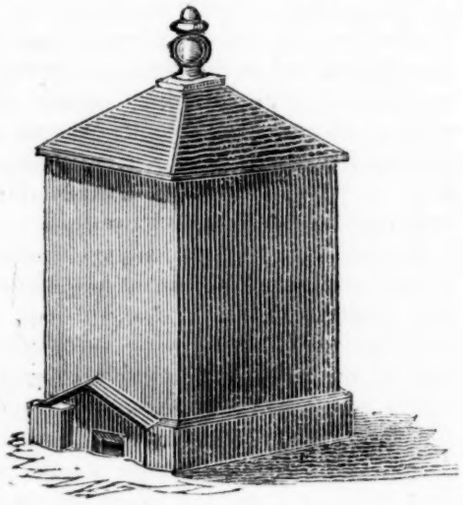
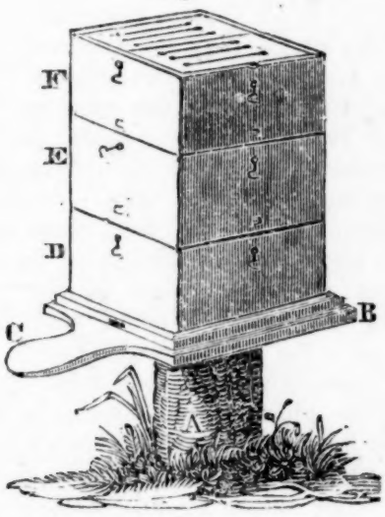


Fig. 2.



this hive, the latter in a state denuded of the external covering, the former with the cover in its place, being the ordinary working state. The pedestal A is a pillar of wood or stone, of any convenient height, and fixed securely in the ground. On the top of the pillar is fixed a piece of stout board, having at each end a perforation or mortice. The stool or basement, B, on which the hive is set, is fastened to the former by means of two staples which pass through the mortices, and secured with two iron or wooden plugs. The stool is a board 14¾ inches square, with a landing place, C, in front, which is rounded off on the upper surface to prevent the lodgement of water. Round this board, at the distance of half an inch from its outer edge, is a frame of wood 1½ inches broad, and 1 inch in thickness. This is fixed upon the upper surface of the stool, having in the front side a door of entrance for the bees. This passage may be made 2 inches in width by ⅓ inch in height on the outside, but widening inward to 3 inches by ½ inch in height. The side of the frame opposite to the entrance is attached to a slip bottom of ½ inch in thickness, fitted to slide out like a drawer, thereby affording the means of cleaning out the bottom of the hive, and on which a supply of food can be placed when necessary. The inside measure of this frame should correspond to the inside dimensions of the boxes.

The body of the hive is made of deal, about one inch in thickness. Its dimensions are 10¾ inches square inside measure, and the total height about 19½ inches, but divided into three stories or compartments, D, E, F, each 6½ inches high, and separable from each other as occasion may require. Each box is furnished with a top and bottom perforated with oblong slits, as seen in the top of fig. 2; these are of hard-wood, ¼ inch thick, and each formed of two pieces. Each half of the tops and bottoms have three slits, each about ⅓ inch in width, and so arranged, that, when the bottom of one compartment or box is applied to the top of any other, the slits shall all coincide to allow free passage to the bees; the bottoms are secured with small buttons, to prevent their falling out in handling, but allowing them to be displaced with ease when the comb is to be abstracted. The boxes are united to each other with hooks and eyes, which must all be placed at equal distances from the edges of the box, to insure the application of any one box to any other of the set. One cover is adapted to fit all the boxes; it is required to be of thick wood, in order that the eyes of the hooks may be at the same distance from the edge as those of the box-

es, its length and breadth being exactly the same as the body of the hive. The cover may be made of a single piece of board, or it may be improved by making it in two layers, with a vacant space between; a few small holes may then be perforated in the lower half, and one larger one in the upper portion, the latter to be stopped with a cork, and opened when occasion requires.

The above is all that is essential to this hive, but the whole may be secured by the cover, fig. 1, the outer dimensions of which correspond with those of the stool or basement, that is 14¾ inches square, and the height sufficient to admit the three boxes or compartments of the hive. A folding flap is provided on the back part of the cover, to allow the slip bottom to be withdrawn and replaced, while in the front, as seen in the figure, a small part is cut away to leave the entrance clear.

In the management of this hive, when a swarm takes place, if the swarm is large, take three boxes, but if small, two will suffice. Should three boxes have been applied, the lower one ought to be removed about the middle or end of September, as there should never be more than two boxes allowed for a hive during winter, nor till the bees have thrown the first swarm; when a first swarm is thrown, add a third box, to prevent after-casts. If it is wished that the hive should not swarm at all, let a third box be added about the 1st of June, when the hive begins to appear crowded, and afterwards a fourth box, if it appear necessary.

To divide swarms, watch the time when the hives become crowded, and when drones begin to appear in the bee garden. Place a stool or basement, with an empty box on it, on each side of the hive you mean to divide, and have at hand a spare cover. Unhook the hive, and draw through between the boxes a piece of thin wire or a thin table knife, to separate any portions of wax that may adhere. In the evening, when the bees are mostly home, move the boxes gently, and insert between them two large sheets of tin plate; lift the upper box with one of the tin sheets, and place it over the box already provided on one of the stools; close the entrance of this stool, and take out the tin plate; put the cover on the other portion of the hive, and remove it to the empty box on the other stool, and when all are properly secured, allow this division to remain open, that the stray bees may settle in it. Let it remain open during the following day, and at night shut it up, using precaution to admit the necessary air, and open the other division. Let the second be shut up, and the first open for twenty-four hours; and if the weather have been fine, you may set both at liberty; but if the weather have been unfavorable for bees going abroad, they must be kept apart a day longer. After this they will continue to work as separate swarms.

The person chiefly employed in shifting the boxes may be protected from the bees by a broad hat with a veil tied round the hat, and round the shoulders, made of calico, with a piece of gauze or cat-gut in front, and on the hands a pair of gloves, and over these a pair of woollen mittens, the clothes well buttoned up and secured.

Should the hive at killing time consist of three boxes, and the lower one be considered but partially filled, and should it, together with the middle one, be sufficient for the support of the hive, the upper box may then be taken away. To do this, disengage the upper box as before directed, and insert the sheets of tin plate; take away the upper box and lay it on a stool at 30 or 40 yards distance. Put the cover on the remaining boxes, and allow the bees free passage in both divisions. The bees in the removed box may be left alone for a little, and all that rise will fly back to the old stool, where, finding the hive as usual, they will remain. The bees in the separated box soon get tame when parted from the body of the hive, and may be blown out with bellows, or thrust out with a quill, and when once they take wing, they will go back to the old stool. Care should be taken at this season of the year to observe if the queen bee be in the separated box, that she may be preserved and put back safely to the hive.

When it is found necessary to feed bees, a trough of tinned iron, 10½ inches long, 4 inches wide, and 1 inch nearly in depth, with a floating lid of nearly the same dimensions, made of very thin fir wood, and bored like a sieve. This is filled with diluted honey, or thin syrup of sugar; and having put the floater upon it, draw out the slip behind, and put in the feeder, which must be so near the size of the opening as not to let a bee pass when it is in, and at the same time allow it to go in freely. The hive is then shut up to prevent other bees from having admission.

When weak swarms are fed in the ordinary way, without shutting them up, the bees of neighboring hives are attracted, who not

only carry off the food given, but, after it is done, continue to rob the weak hive of all their store, if they have any. Feeding in this way often does harm rather than good.

In feeding, it is advisable to give the bees daily as much as the feeder will contain for a succession of days, if they continue to take it up, until they have got what may be considered proper or sufficient. During this time they are closely shut up, and after feeding is dropped, let them be kept in till they settle, and till the neighboring swarms, if they be in motion, settle also, when the passage may be left open. This prevents them from being the prey of neighboring swarms.

Spontaneous Ignition: *Late Fire at the Dublin Custom House.*—It having appeared, in the course of the inquiry into the origin of this conflagration, that thirty-six bales of cotton waste wool, for candle wicks, had lain in store between forty tallow casks on one side, and ten leaky casks of palm oil on the other, Mr. O'Connell, who attended on the part of the merchants, suggested that the fire might have been caused by the oil mixing with the wool, and producing spontaneous combustion; in support of which view of the matter he quoted sundry passages from "Henry's Chemistry," and other scientific works. Mr. Oldham, the engineer of the Bank of Ireland, being examined, stated the particulars of three spontaneous fires which had occurred at the printing-room of the Bank, amongst the oiled rags which had been used to wipe the printing plates, and had then been thrown by in a heap, and he declared his conviction, that if the warehouse people in the custom house had made a pile of sticks, and applied a light, they could not have kindled a fire more effectually than they had, by allowing oil to leak in amongst loose cotton and wool. Mr. Ainsworth also declared his opinion of the probability of the fire arising from the mutual action of the cotton, hemp, or wool, and the leaking oil. Mr. Edmund Davy, professor of chemistry to the Royal Dublin Society, to the surprize of every one, stated his opinion to be that the fire could not have occurred spontaneously; that he was not aware that the fixed oils had any effect on cotton or wool when mixed with them in any proportion; that he had not read the opinion of any eminent chemist which differed from his; that all the authors who had written on the subject had written from hearsay, not from their own experiments; and that he was convinced a chemist might make a thousand experiments, with an earnest desire to accomplish the ignition of wool or cotton and oil, by mixing them together in every proportion, and yet would not be able to succeed. He thought that, if ever such apparent spontaneous combustion did take place, it was caused by circumstances which had not been observed, or taken into account at the time.

A Portable Dry Dock.—A gentleman of our city, who was recently at Pittsburg, has described to us a Portable Dry Dock, which is in advantageous use there, and which should be introduced in every sea port in the United States. It is formed of strong timber, well planked at the sides and bottom, and at one end. At the other end a gate is constructed, such as is sometimes used as a lock gate, which is closed when required, so as to form a firm and perfect barrier against the admission of water. At the planked and fixed end of the Dock is placed a small engine, the cost of which did not exceed three hundred dollars. This is employed to work four pumps, by which the water is taken from the dock with rapidity and ease.

When a vessel is about to be "taken into dock," certain valves of the simplest construction are opened, and the dock is immediately filled with water: assisted by stone ballast, it sinks to a sufficient depth to admit the vessel; the gates are then opened, and she is floated in. In five hours from the time the preparations to take in a vessel are commenced, she may be admitted into the dock and safely "shoved up," so as to enable the carpenters to work at the bottom with perfect security and comfort, and in an ample space.

The whole cost of this dock did not amount to twelve hundred dollars. It has been in constant and successful use at Pittsburg for upwards of two years, and no doubt of its competency for all the purposes of repairing the bottoms of vessels, and for all the uses of "Dry Dockage," is there entertained.

This "Dry Dock" has been used on the Ohio for the repairs of steamboats of the largest class, exceeding 600 tons in burden, and, therefore, as large as most of the shipping on the sea-board of the United States.

During the prevalence of the cholera on the Ohio last summer, a large steamboat went to Pittsburg to repair: that fatal disease was supposed to prevail on board of this

boat, and objections to her repairing near Pittsburg were loudly expressed. She towed the dry dock down the Ohio, and having carried it to a proper place, she went into it, was completely repaired, and then towed it back to Pittsburg.

The inventor and constructor of this valuable work is Mr. Thomas Cunningham, of Pittsburg, now residing there: he is an ingenious, industrious, and respectable mechanic. If this notice of his work shall promote his fortune, the gentleman who has communicated this statement will be highly gratified.

It is understood that Mr. Cunningham has obtained a patent for his Portable Dry Dock.

Essay on economizing Fuel and Lighting in Private Dwellings. By the Rev. Patrick Bell. [From the Quarterly Journal of Agriculture.]

I. The Economy of Fuel or Heating.—Of all the substances now used for fuel, coal, it must be admitted, takes the pre-eminence. It has been divided by Thomson into four species, viz. caking-coal, splint-coal, cherry-coal, and cannel-coal. The first, or caking-coal, is that which abounds in the Newcastle coal field. Its value as a fuel stands very high; and, from experiments, the fact has been ascertained, that in a well constructed furnace, 1·2 lb. of it will raise a cubic foot of water from the temperature of 52° to 212°, the boiling point.

Splint or hard coal is that which is found abundantly in the coal-fields of Glasgow and Ayr. Experiments made upon this coal have shown that 3·13 lb. are required to raise the temperature of a cubic foot of water from 52° to 212°. Its relative value, therefore, as a fuel, compared with Newcastle coal, is the proportion of 1 to 2·6.

Cherry or soft coal is the species that abounds in Fifeshire, (that of Mid and East Lothian being intermediate between the cherry and the splint-coal.) This coal inflames readily, giving out much heat. Its power of heating seems to be about one-third less than caking coal, 1·5 lb. being required to raise a cubic foot of water from the temperature of 52° to 212°.

Cannel-coal is found less or more abundant in most of the coal fields of Scotland, and in some of those of England. During combustion it yields a great deal of light, and its heating power is found to be nearly the same as that of splint.

Wood, which holds the next place to coal as an article of fuel, is subject to great variety in heating power, some species of timber possessing that in a much higher degree than others. Generally speaking, old full grown healthy timber yields most heat, but such timber is of too much value for other purposes to be applied as fuel in this country. The following table is given on the authority of Count Rumford, and others, exhibiting at one view the power of various species of wood in producing heat. The number indicates the quantity of timber in pounds, required to raise the temperature of a cubic foot of water from 52° to 212°.

Lime-tree, 3·10 lb.; beech, 3·16; elm, 3·52; oak chips, 4·20; ash, 3·50; maple, 3·00; service-tree, 3·00; cherry-tree, 3·20; fir, 3·52; poplar, 3·10; hornbeam, 3·37.

The next substance in the order of importance is peat. This fuel varies much in quality, according to the situation in which it is produced. Dr. M'Culloch has divided it into five classes,—Mountain-peat, Marsh-peat, Lake-peat, Forest-peat, and Marine-peat: the names implying the locality of their production. Of these, the Mountain-peat, from its loose spongy texture, is the least productive of heat; and, in all the kinds, the heating power is in the ratio of the density of the mass. From experiments it appears that, on an average, 7·6 lb. are required to raise the temperature of a cubic foot of water from 52° to 212°; but were the peat compressed by a proper machine, there can be no doubt that its heating power would be considerably increased.*

Coke and charcoal are substances prepared from any of the preceding, by submitting them to combustion, under circumstances that exclude them either entirely or partially from the access of atmospheric air. The substances thus prepared vary in the same proportion as the originals from which they are prepared; but it has been stated generally, that 1·1 lb. will raise a cubic foot of water from 52° to 212°; of wood-charcoal 1·52 lb., and of the charcoal of peat 3·28 lb., will each produce the same effect.†

I have thus endeavored to give a comparative view of the heating power of the different substances now in common use as fuel;

---

* The experiments of Mr. Todd, on the compression of peat-moss, show that the heating power of compressed peat is at least equal to that of common coal, taking weight for weight.

† We believe that the charcoal of *compressed* peat has not yet been submitted to the test of experiment. The subject is of some importance; and the individual who would conduct a series of experiments, to determine its value, would confer a benefit on the country.

but to give a scale of the comparative cost of these is a department of the subject that cannot be entered upon in this paper, seeing that it is loaded with so many contingent and local circumstances. The economist must, therefore, take the data that are here furnished, and laying these to the expense attendant on the procuring of the fuel within his reach, he will draw his conclusions accordingly.

The next point of consideration is the means of applying, with the greatest advantage, the fuel already described, and the means of distributing the heat in our apartments. Three different modes have been adopted,—that of the open fire, the common and the heated air stoves, and also the agency of steam. In the first method, which is the most generally adopted in this country, considerable saving of fuel may be effected by attending to the following remarks. Since the heat that a room receives from an open fire arises chiefly from radiation and reflection, it is important that the position of the grate in which the fuel is burnt be attended to, and of this the position of the covings has a considerable influence. These, when placed at a proper angle, give out a large portion of heat by reflection, in aid of that sent out direct from the front of the fire-place by radiation. The angle that is considered the best for effect is that of 45°. In fixing grates, the less the quantity of solid matter that is used, so much greater will be the heating effect of the fire, as such solid matter serves as a conductor to carry off heat in a direction contrary to what is wanted. The flue also has its share of influence. This ought to be as large as possible, to be regularly formed, free of abrupt turns, and to have a smooth surface; the throat, or lower part, should be somewhat contracted, and the chimney top ought to be sloped upward, or brought to a comparatively thin edge, instead of the level surface too frequently adopted. It has been ascertained by experiment that a well constructed grate will consume about 1 lb. of coal per hour for every three inches of its length,—that is to say, a grate of 15 inches fire-place will burn 5 lbs. of coal per hour.

Heating apartments by means of stoves, though much resorted to on the Continent, has never to any extent been introduced into Britain. In the common stove the heat is procured entirely by radiation from the surface of the stove and flue; but it is found not to afford such a salubrious atmosphere as the open fire, where a constant and rapid current of air is received and passed through the room. *Heated air* stoves have of late years been successfully employed for heating large establishments, as hospitals, churches, &c. In this, the stove is usually at a little distance from the apartments to be heated. A current of air is heated by passing it over a cockle, from which it is carried into flues to the different points where its effects are required. This appears to be an economical method of heating such large establishments, but it seems not so well adapted to ordinary dwelling houses.

The last method of heating apartments, that we have to notice, is by steam. This powerful agent, besides its being so admirably adapted to impel machinery, appears also to be the most economical for the diffusion of heat through a suite of apartments, and has been adopted with perfect success in many of our manufactories. In these, the practice is to carry a system of cast iron pipes through the apartments to be heated. Steam is received into these from a boiler; the metal is heated, and gives it off again by radiation to the apartment. This, though a very effective mode of accomplishing the object in such situations, is yet of a nature not suited to the elegance of modern dwellings, more especially as the open grate forms an ornament of no small importance in our best rooms. Could the prejudice, however, be once overcome, there could be no difficulty of introducing the system of heating by means of steam into all sorts of dwellings, and the following method of arranging the apparatus is submitted.

In the kitchen a boiler of considerable dimensions is to be set in a furnace, with all the requisite appendages of safety-valve, feed-pipe, &c. A large steam pipe passes from the boiler, through the kitchen, and along the passages, branches from which enter every apartment, each provided with a stop-cock, to shut off the supply of steam when requisite. To determine the size of the boiler, we shall take a particular example—a house of 50 feet by 20 feet. To heat this house, the boiler has a capacity of 10 cubic feet, and being of the usual waggon-shape, its dimensions are 3 feet long, 2 feet wide, and 2 feet deep; such a boiler requires a supply of water equal to 4 cubic feet for every 12 hours it is kept boiling, and a bushel of coal is sufficient to keep a constant supply of steam for a day. The same boiler may be made subservient to the ordi-

nary purposes of the kitchen by allowing the steam to pass into a properly constructed vessel. Perhaps the best construction for this is, that the vessel intended to contain the fluid that is to be boiled should be incased within another of the same form, but leaving a space all round the sides and bottom to contain the steam, having a stop-cock to draw off any water that may be condensed during the operation.

Any number of such vessels may be ranged upon a stand, each connected by a branch and stop-cock to a steam-pipe from the boiler, and they may be all made to boil together, or any one or more of them, as may be required. The outer surface of these cooking vessels should be kept bright, in order to prevent the loss of heat by radiation, while the steam-pipes for heating the house should be kept black on the surface, to promote radiation as much as possible. For this reason, pipes of cast iron are better for heating rooms than those of tin plate. With the diameters equal, it has been found that double the length of tin-pipe is required to yield the same quantity of heat that would be derived from cast iron. With cast iron pipes of four inches diameter, a room of ordinary dimensions may be kept at a temperature of 62° with a boiler whose entire capacity is six cubic feet. In constructing an apparatus of this kind, the steam-pipes should be all laid with an inclination towards the boiler, that the condensed steam may run back to the boiler, thereby supplying it with hot instead of cold water, by which a saving of fuel is effected. In this variable climate, especially in winter, much inconvenience is often experienced in the drying operations of the laundry: this might be obviated by applying steam to that purpose, in a room properly fitted up.

II. Economy of lighting Private Dwellings.—In this branch of the subject I shall pass over the ordinary methods of procuring light from oil, tallow, wax, &c. and consider only the modern improvement of lighting by gas procured from coal—an invention which must be considered amongst the most remarkable discoveries of this discovering age. It is not necessary to go into a historical detail of the steps by which the discovery was effected; our purpose will be better answered by giving an account of a small gas apparatus which was constructed, and has been kept in use for two years, for lighting a small private house in the country, remote from gas works, properly so called.

The first attempt at this apparatus originated in the idea of placing a retort in the kitchen fire. It was soon found that the heat of an ordinary fire is insufficient to decompose the coal in the retort, so as to yield the full quantity of gas that might be expelled from it. It was also found to be very inconvenient in other respects. Recourse was now had to the erection of a small house to contain the whole apparatus. The dimensions of this building were twelve feet long by nine feet wide and nine feet high. Before describing the apparatus it may be well to glance at the principles on which the process of making coal gas depends. It is to be observed that every kind of coal yields gas; but the different kinds yield products which differ widely both in quantity and quality. Cannel coal has been found to yield not only a greater quantity, but also a purer gas, than any of the other species of coal, and, as a matter of course, is always to be preferred when it can be procured. The gas is extracted from the coal by a process of distillation, whereby the volatile parts are driven off in the form of a crude gas, combined with a variety of other substances, the principal of which are tar and water of ammonia. When the gas has left the retort in which the distillation is carried on, it is first freed of the tar and water by condensation in vessels exposed to cold; it is then brought into contact with lime, by which the remaining portions of offensive matter are absorbed: this consists chiefly of sulphur, which, being combined with part of the gas, forms sulphuretted hydrogen, but the lime having a strong affinity for that substance, they combine, and leave the gas in the state of carburetted hydrogen, sufficiently pure for use.

The apparatus now to be described is represented in the two annexed cuts. Of these fig. 1 is a ground plan of the house and apparatus, and fig. 2 being a prospective view of the same, in which the front wall of the house is supposed to be removed; the same letters of reference applying to both figures. A is the furnace with the retort; the latter is 15 inches long and 5 inches diameter, of cast iron, and contained a charge of 8 lbs. of coal. To the upper side of the retort, and near its mouth, is joined an iron pipe, B, about one inch in diameter, left open at top, for the purpose of cleaning off the crust of tar that forms on the inside, but while in operation the opening was closed with a wooden plug. The sloping pipe, C, conveys the gas onward to

Fig. 1.

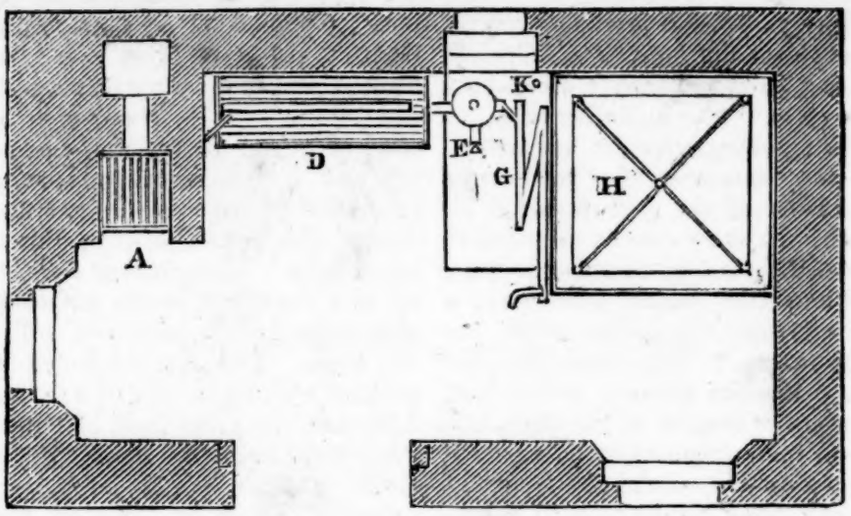
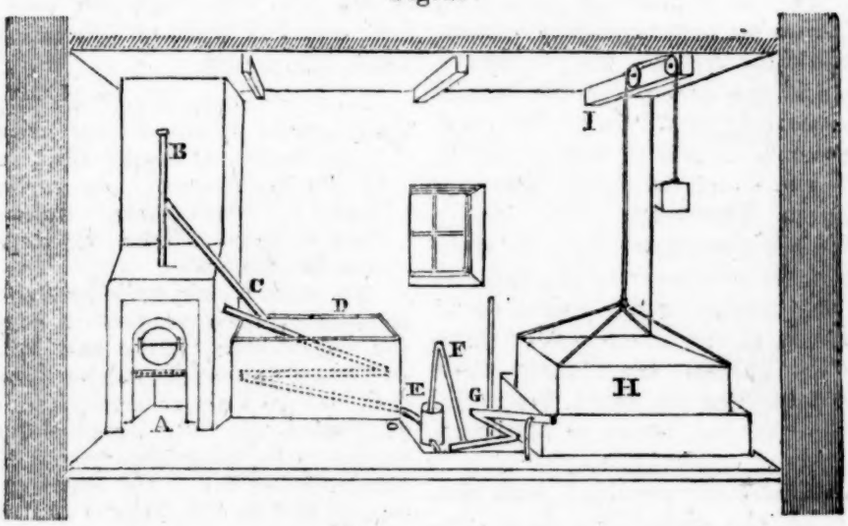


Fig. 2.



the cooler or condensing vessel, D. This is an oblong trough, which being kept full of cold water, and the pipe which thus conveys the gas being made to traverse the trough in the direction of the dotted lines, having at the same time an inclination towards the tar cistern. This retardation and cooling promotes the deposition of the tar and watery parts, which are borne forward by their own gravity along the slopes of the pipe, while the gas thus separated is pushed onward by the pressure from the retort, until they arrive in the cistern E. The tar and water are deposited in the bottom of this vessel, which is air tight, except by the insertion of the bent pipe F, by which the gas is allowed to pass off towards the purifying vessel. The tar cistern is also furnished with a plug in the bottom, by which the liquids can be drawn off when they accumulate. The purifying vessel G is composed of three inclined pipes, joined as in the figure: these are open at top and bottom, but fitted with plugs for the conveniency of filling and discharging the purifying liquor. This vessel is filled about two-thirds full of slacked lime and water brought to the consistency of thin cream, and the gas being forced through this by the pressure from the retort, it is deprived of the sulphur with which it was combined. The gas now passes through the small pipe connected with the upper end of the purifier, and enters the gasometer H from below. The gasometer is a vessel in which the gas is stored up for use. It consists of two parts, the tank and the gasholder: the tank or lower part is filled with water, and the gasholder, which is an inverted ves-

sel, is a few inches less in diameter than the tank, to give freedom to its motions within the other. The gasholder is suspended by a rope or chain over the pulleys attached to the beam I, and balanced with a weight attached to the rope. The induction pipe, after leaving the purifier, descends, and, entering through the bottom of the tank, rises again in the inside of the gasholder, till its extremity is an inch or two above the surface of the water. The end of the pipe is here furnished with a cup, which constitutes a water valve, allowing the gas to enter, but preventing its return.* The induction-pipe is placed in a manner similar to the last, passing through the bottom of the tank, and rising again on the outside as at K, where it is furnished with a stop-cock, and from this point the branch pipes can be carried to the apartments that are to be lighted.

From the way in which this apparatus was erected, even an approximation cannot be made to the total expense, but, exclusive of the house and the gasometer, the actual outlay amounted only to £2 7*s.*† The gasholder being a cube of 3 feet, it contains 27 cubic feet of gas, which supplied three single jet burners. The retort was usually charged with eight pounds of coal, and eight pounds more were required for the furnace to work off this charge, which produced 27 cubic feet of gas, at the small cost of three halfpence. This quantity supplied the three burners for a period of six hours, hence the cost of one light for six hours is one halfpenny.

From the experience acquired with this simple apparatus, the writer has no hesitation in saying, that a country house, even of ordinary extent, may be conveniently and profitably lighted with coal gas; but he would recommend that the different parts should be substantially constructed, and on a larger scale than is here described.

Note.—The apparatus here described is exceedingly simple, and very well adapted for an establishment on a small scale, but it may be proper to remark, that, in extending it, some deviation would be advisable. In the first place, the crude gas should pass the tar-cistern before entering the condenser, and if, as should always be the case, the cistern is placed at a considerable distance from the retorts, a great part of the tar is deposited during its progress thither. Again, one of the best condensing apparatus is a train of pipes, set on end, and connected at top and bottom alternately, so as to form a continuous course for the gas, and arranged so that the tar will always run towards the tar-cistern. The purifyer may be constructed in a variety of ways, and these will vary also as the lime is employed in the wet or the dry state. The gasholder should be always made of sheet iron, and of a cylindrical form. The tank may be built of stone or of cast iron, wood being the most objectionable material, from its liability to decay in such situations. When gas is used regularly, and properly attended to, a single jet-burner consumes one cubic foot per hour, emitting a light equal to three or four tallow candles of six in the pound.

* In the large gas works this valve is not used in the gasometer, but a more efficient method is adopted to prevent the return of the gas to the retort, by means of what is called the hydraulic main; this is a tubular vessel, placed horizontally, and kept half full of water, the pipes from all the retorts dip into this liquid, and through it the gas is forced by the pressure from the retort, but is effectually prevented from returning by the intervention of the water.

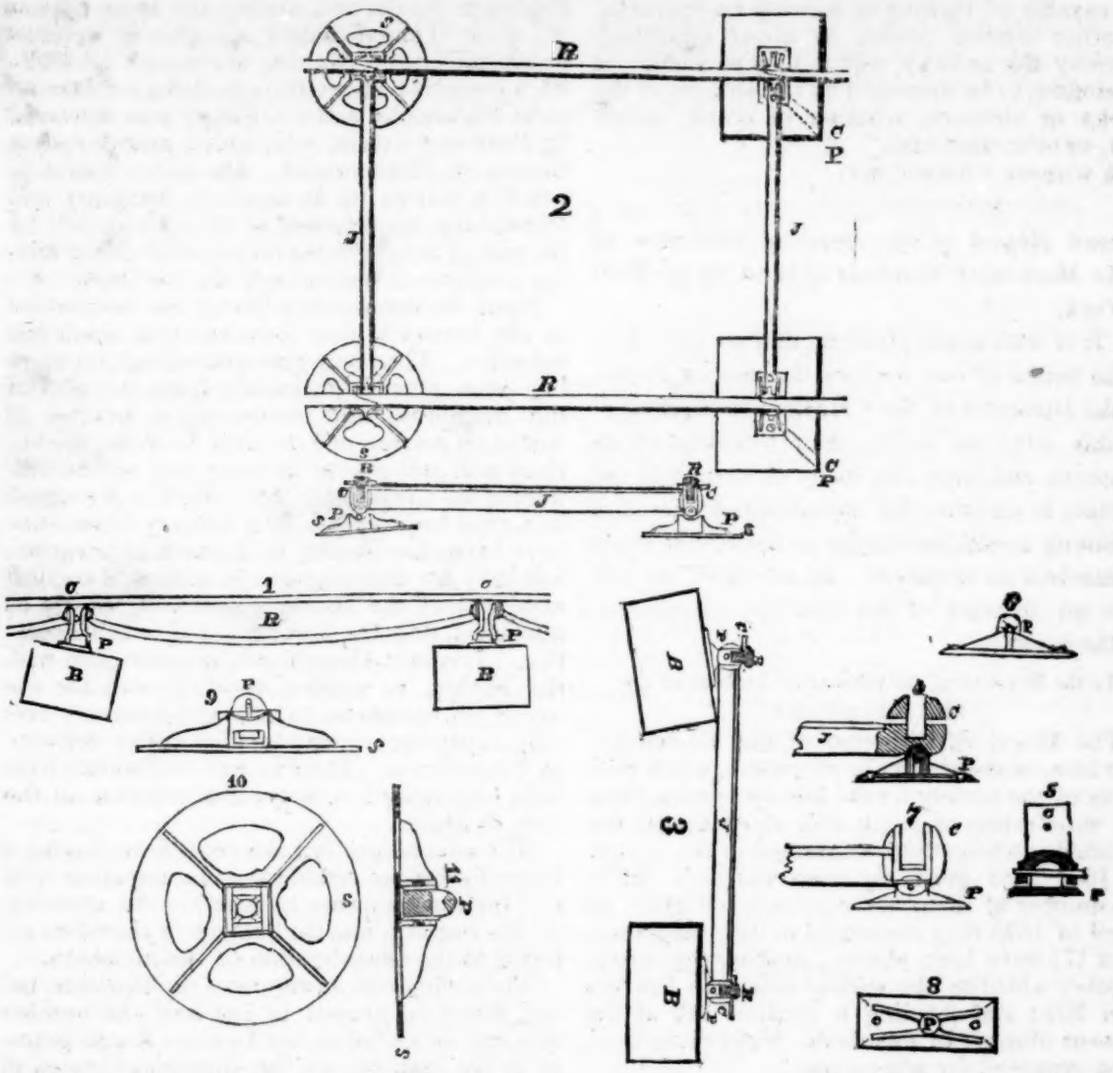
† Equal to $9.75.

Specification of the Patent granted to William Jessop, *of Butler Hall, in the County of Derby, Esquire, for certain Improvements in constructing Railways.* Dated June 1, 1833. [From the Repertory of Patent Inventions.]

To all to whom these presents shall come, &c.—*Now know ye*, that in compliance with the said proviso, I, the said William Jessop, do hereby declare the nature of my said invention, and the manner in which the same is to be performed, are fully described and ascertained in and by the following description thereof, reference being had to the drawing hereunto annexed, and to the figures and letters marked thereon: that is to say,

My invention relates to the manner of constructing the chairs in which the rails are fixed, that is, in place of the usual mode of fixing and supporting the chair upon a stone block, wood, or other sleeper, the chair is made distinct from the pedestal, which is attached to the stone block, wood, or other sleeper, and the chair and pedestal are connected by a universal joint or hinge, which permits the pedestal to adapt itself to any irregular sinking of the block or other support upon which it rests, and insures a firm and solid bearing on its base; or this may be effected by the combined motion of a hinge-joint, or other means, permitting motion between the pedestal and chair, and a moveable joint formed at the junction of the chair and rail, so as to produce the same effect, and thereby answer the purpose of a universal joint.

Description of the Drawing.—For the better understanding the improvements, I will now describe the drawing, which represents several simple methods of constructing the universal



joint, although it may be effected by other means familiar to the practical mechanic. R R are the rails. C C, the chairs. P P, the pedestals; and B B, the blocks or sleepers. J J are junction bars of cast or wrought iron, by which the opposite chairs are connected together, and the rails are thereby held parallel to each other, and at a proper distance apart, and are also retained in a suitable position to insure a flat bearing on the surfaces of the rails for the wheels to travel upon. S S are cast iron bed-plates or sleepers, which may be used to support the rails where stone is expensive, so constructed that the pedestal may be readily adjusted, by the introduction of a wedge or packing to a proper level, without disturbing the seat which the bed-plates may have acquired on the ground; the same method of construction being applicable to the pedestals, when they are attached to stone blocks.

Fig. 1 is a side view of the railway.

Fig. 2, the plan.

Fig. 3, the cross section; two of the stone blocks, B, are drawn in an inclined position, to show the action of the pedestal.

Figs. 4 and 5 are sections of the pedestal and chair, showing an obicular universal joint, by means of which the pedestal adapts itself to any irregular sinking of the stone block or other sleeper, whilst the connecting or junction bars retain the rails in their proper gauge, and their opposite surfaces in the same plane or straight line.

Figs. 6, 7, and 8, are other views of the pedestal and chair.

Figs. 9, 10, and 11, are a side view, plan, and section of a cast iron bed-plate, used as a substitute for the stone blocks: showing also the method of adjusting the rails by means of wedges or packings introduced between the bed-plates and the base of the pedestal, which is made to fit in the recess formed on the bed-plate, and secured laterally by means of a wedge or key.

Having now described the nature of my invention, and the manner in which the same is to be performed, I would have it understood that I lay no claim to various parts shown and described, but do hereby confine my claim of invention of improvements in constructing railways to the using of chairs and pedestals which

are capable of turning or moving an universal or other similar joints, as above described, whereby the railway will not be so liable, as heretofore, to be deranged by the sinking of the blocks or sleepers, whether of stone, wood, iron, or other material.

In witness whereof, &c.

Second Report of the Board of Directors of the Mechanics' Institute of the City of New-York.

It is with much pleasure that we introduce to the notice of our readers the second report of the Directors of the "Mechanics' Institute" in this city; we solicit their attention to its contents, and hope that many of them will not hesitate to embrace the opportunities offered of obtaining useful knowledge to those who enrol themselves as members. In our next we will give an abstract of the laws and constitution of the society.

To the Members of the Mechanics' Institute of the City of New-York:

The Board of Directors of the Mechanics' Institute, in reporting the proceedings and progress of the society for the last two years, have the satisfaction of being able to state that the favorable anticipations contained in the report of 1831 have generally been realized. In it the number of members was stated at 112. In April of 1832 they amounted to 242; and since then 171 have been elected, making the whole number added to the society since the last report 301; and forming a total of 413 as the present number of members. Many more have been proposed for admission.

During the same period the receipts of the society, for dues, initiations, and the sale of tickets to the lectures, have amounted to $1,516.55, which, added to the balance in the treasury, as per last report, $174.58, makes an aggregate of $1691.13. The payments have been, for the delivery of lectures before the Institute, $812.50—purchase of books for the library, a book-case, &c. $210.69—contingent expenses, $581.62—making the total expenditure $1604.81, and leaving in the treasury at this time $86.32. There is due to the society from 72 members for initiation fees, $154—for annual dues in arrear, $283—dues of the present year, $815—total, $1252. Of this sum it is presumed that about two-thirds will be collected, or $835; and if we estimate the accession of new members during the coming winter at 200, which the former increase of the society fully warrants, their initiation fees and dues will give the further sum of $800; making altogether an available sum of $1635 to meet the current expenses of the year.

The first course, consisting of thirty lectures on Natural Philosophy and Chemistry, was delivered during the winter of 1831–32, by Professor Steele, and during the same season Mr. E. J. Webb delivered a course of lectures on Architecture. During the winter of 1832–33, a course of about forty lectures on Mechanical Philosophy and Chemistry was delivered by Professor Steele, who added gratuitously a course on Mathematics. Dr. Elder also delivered a course of lectures on Anatomy and Physiology, the expense of which was paid by the sale of tickets to the members, without having recourse to the funds of the Institute.

Since the last report a library has been added to the Institute, now consisting of about 500 volumes. This new and interesting creation has been formed principally from the gifts of the members, and embraces a number of works on science and the arts, to which the curious and industrious inquirer may resort with undoubted advantage. The whole is preserved in a good book-case. The Library Committee have been empowered to appoint a librarian, and they are now engaged in making a detailed catalogue of the books, which will shortly be published, and the library placed in full operation. It is in contemplation, in connection with the library, to open a reading-room for the use of the members, to be kept open every evening excepting those occupied in the delivery of the lectures. The Finance Committee have been empowered to appoint a collector of the dues in arrear.

The advantages to be derived from having a Drawing School established in connection with the Institute appears to deserve the attention of the Society, and the subject is therefore referred to the consideration of the members.

The number of members of the Institute being found to exceed by one-half the number that can be seated in the Lecture Room granted to the Institute by the Common Council of the city, it has become necessary, in the opinion of the Board of Directors, to provide a more spacious place, and in a more central situation. For this purpose every large room between the City Hall and Grand street has been examined, but not one has been found fitted for the due enjoyment of experimental lectures by a numerous society, though capable of accommodating very large assemblages for less intellectual pursuits. Under these circumstances, the Directors relinquished the hope of finding a more central Lecture Room, and turned their attention to Clinton Hall as possessed of the requisite accommodation so desirable for the Society. It has been engaged for the ensuing course; and it is believed that a considerable sum may be realized from the sale of tickets for the admission of ladies and others, whose introduction may be permitted without the danger of excluding any of the members.

The Constitution of the Society, as altered and amended, together with its Code of By-Laws, and Regulations for the government of the Library and Reading Room, have been printed for the use of the members.

The Institute was incorporated by an act

passed at the last session of the Legislature, and, among other beneficial provisions, the act permits it to hold real estate to an extent sufficient for its prospective wants; and it remains for the Society to consider by what means the boon can be made available. When we see our lectures delivered in an obscure apartment, situated in a part of the city remote from the great body of mechanics and artists, attended by a crowd of new members partially accommodated by the forbearance of that portion of the Society who have enjoyed former courses, and when we know that others who would wish to attend are deterred by the conviction that they cannot get seats, can we doubt that the Institute, if possessed of a spacious lecture-room in an eligible situation, would count its members by thousands, where it now counts by hundreds? The thirst for knowledge is on the increase, and it cannot be otherwise in our free and happy country, in which, so far as the Constitution of the State of New-York governs, every man is on an equality: compelled by the laws to perform militia duty and other laborious public services, and entitled, by the election of his fellow citizens, to the highest and most responsible employments in the State. Enjoying equal political rights, freemen should have no rivalry but in the pursuit of knowledge to which every consideration of honor and interest stimulates. Without a progressive improvement in his art, founded on modern science, the artist must be overtaken by the wonderful machinery now introduced, and degraded to a state of inferior comfort and respectability. This knowledge, which is so necessary now, and which so few have had an opportunity of acquiring in their school-boy days, can be obtained by joining this Society, at the low price of two dollars a year, in addition to the initiatory fee of two dollars; and an attendance on the lectures delivered before this Society, for two or three seasons, will put the attentive hearer in possession of all that the student at college acquires in the same time on the same subjects at a great expense. To suppose that the opportunity of attending the lectures of the Institute, if fairly and fully presented to our fellow citizens, would not be embraced, is to libel them, and the discreditable thought must not for a moment be entertained; but to present it to them thus fairly and fully, it is necessary to have a large and well arranged Lecture Room, situated in an eligible and central position. Such a room, with the other apartments which would necessarily be in the same building, if erected by this Society, the Board of Directors feel confident could always be let to advantage, when not required by the Institute. The expense of the ground and the building would of course be considerable; perhaps the amount could be raised on shares, in the form of stock, but no definite measure can be proposed at this time. Much may depend on a location, and the members are therefore invited to direct their inquiries for two or three lots of ground in Broadway, the Bowery, or the space between these two thoroughfares, not higher up than Broome street.

Guided and supported by the intelligent men who first formed the Institute, and by the many worthy members who have since been added to it, no doubt can be entertained that it will continue to increase in numbers and in usefulness.

American Institute.—In our peregrinations through the Fair at the "American Institute," we noticed, and barely noticed, the excellent specimens of stationary of all kinds, exhibited by David Felt, of Stationary Hall, in this city. Accustomed as we are, in the prosecution of our labors, to pens, ink, and paper, when we escaped for a short time from the use of them, to behold the great display of ingenuity exposed there, we passed them by as matters which at the moment we were glad to avoid. The pen with which we write this notice, and the ink also, are from his establishment, and we are bound to say that we never used better either in this country or in Europe. We noticed in our last that Mr. Felt obtained a premium, and we can bear testimony to its being most deservedly bestowed. The elegant and substantial manner in which his account books are manufactured is most praiseworthy.

The City Hall Reporter, and New-York Law Magazine. Edited and published by John Lomas.

To the members of the bar the title of this work implies all we could say to excite a curiosity to read its contents. The general reader, who has a taste for that mental and *moral* science which so accurately investigates our relative duties and obligations, who is delighted with the display of talent and profound learning, and who is deeply interested in the biography of stars of the first magnitude, will find in the pages of the Reporter much to amuse, engross, and instruct him. We trust that we shall occasionally find in its pages something quite appropriate to our columns.

To the Editor of the Mechanics' Magazine:

Sir,—I will thank you or some of your correspondents, to inform me of the best manner of making brass and tin lacquer, to prevent the sun from fading the color.

Yours, &c. A Subscriber.

METEOROLOGICAL RECORD, KEPT IN THE CITY OF NEW-YORK,

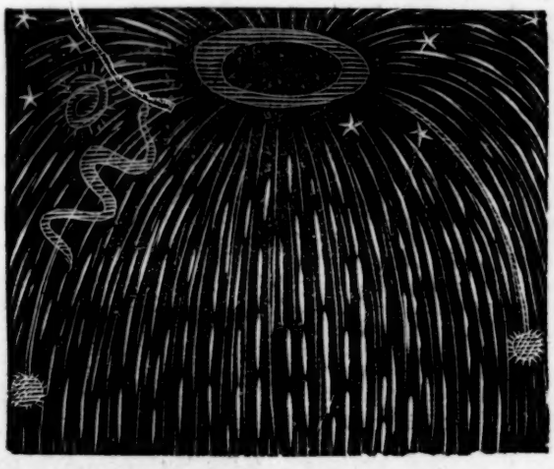
From the 19th day of October to the 9th of November, 1833, inclusive.

[Prepared expressly for the Mechanics' Magazine and Register of Inventions and Improvements.]

Date.	*Hours.*	*Thermometr.*	*Barometer.*	*Winds.*	*Strength of Wind.*	*Clouds from what direction.*	*Weather.*
Octob. 19..	6 a. m.	45	30.33	W—NW	moderate	WSW	fair
	10	50	30.40	NNW	..	..	..
	2 p. m.	53	30.38	..—SE	faint	..	..
	6	50	30.38	..	..	..	..
	10	50	30.41	..	..	..	cloudy
" 20..	6 a. m.	43	30.33	NE	moderate	ENE rain scuds	rain
	10	42	30.35	..	fresh	NE ..	..
	2 p. m.	44	30.32	..	..	.. ..	..
	6	43	30.26	..	..	.. ..	..
	10	42	30.26	..	..	.. ..	..
" 21..	6 a. m.	44	30.12	..—ENE	mod.-fresh	.. ..	..
	10	45	30.10	NE	—..	.. ..	..
	2 p. m.	46	30.05	..	moderate	.. ..	..
	6	47	30.03	..	fresh	.. ..	..
	10	47	30.00	..	..		
" 22..	6 a. m.	48	29.83	NNW	moderate	NNW—NW	rainy
	10	48	29.89	NW—NNW	..	WNW	..
	2 p. m.	52	29.87	W—W by N	..	S / WNW	cloudy
	6	49	29.89	W by N	..	..—WSW / W	fair
	10	47	29.94	WSW	..	SW	..
" 23..	6 a. m.	40	30.01	SW—N by W	..—fresh	..	..
	10	47	30.08	SW by W	fresh	..	..
	2 p. m.	54	30.06	..	..	..	..
	6	52	30.04	..	..	..	.. —hazy at SW and W
	10	48	30.04	..	..	..	..
" 24..	6 a. m.	48	29.94	SSW	moderate	..	.. —hazy at E
	10	53	29.92	..	..	..	..
	2 p. m.	59	29.80	..	..	..	..
	6	56	29.70	..	..	..	..
	10	54	29.70	..	..	SW by W	..
" 25..	6 a. m.	53	29.67	SW	..	..	cloudy —fair
	10	55	29.65	WSW	..	..—WNW	fair
	2 p. m.	58	29.62	..	..	W	..
	6	55	29.67	..	..	WSW	..
	10	52	29.70	..	..	..	..
" 26..	6 a. m.	48	29.76	W by S	..		clear
	10	52	29.80	..	fresh	..—W by S	.. —fair
	2 p. m.	54	29.77	..	..	W by S	fair
	6	52	29.82	W	moderate	W	.. —clear
	10	48	29.92		fresh		clear
" 27..	6 a. m.	45	29.95	WSW	light	SW—W	fair —hazy —cloudy
	10	50	29.91	..—SSW	.. — mod.	..	.. — ..
	2 p. m.	59	29.78	SW by S	fresh	..	cloudy
	6	54	29.79	..	moderate	..	..
	10	52	29.81	..	..	..	..
" 28..	6 a. m.	46	29.81	NW	faint	..	..
	10	50	29.81	WNW	..	..	fair
	2 p. m	53	29.79	W	moderate	W—W by S	..
	6	46	29.80	..	..	W by S	..
	10	44	29.82	..	..	..	..
" 29..	6 a. m.	37	29.97	NW	faint	WNW	clear
	10	44	30.00	..	moderate	..	fair snow at Richmond and at
	2 p. m.	47	29.95	..	fresh	..	.. Ashtabula, twelve inches.
	6	42	29.98	..	..	..	..
	10	41	30.00		moderate	..	..
" 30..	6 a. m.	38	30.09	WNW	..	..	..
	10	40	30.15		fresh	..	..
	2 p. m.	42	30.20	W	..	..	..
	6	39	30.30	..	..	..	..
	10	36	30.39	..	..	..	..
" 31..	6 a. m.	32	30.48	..	..	NW by W	..
	10	37	30.48	..	..	..	..
	2 p. m.	41	30.48	..	..	..	..
	6	39	30.47	NNW	..		clear
	10	36	30.50	WNW			..
Novem. 1..	6 a. m.	32	30.50	WSW	moderate		..
	10	40	30.40	S	..		..
	2 p. m.	49	30.30	SSW	..		..
	6	45	30.12	SW	..		..
	10	45	30.05	WSW	..		..

CITY OF NEW-YORK—CONTINUED.

Date.	*Hours.*	*Thermometr.*	*Barometer.*	*Winds.*	*Strength of Wind.*	*Clouds from what direction.*	*Weather.*
Novem. 2..	6 a. m.	45	30.03	WSW	light	SW	fair —thin cirri
	10	47	30.02	WNW	..	..	..
	2 p. m.	50	29.02	..	..	W by N	..
	6	53	30.05	..	..	..	..
	10	48	30.10	NNW	..	..	..
" 3..	6 a. m.	43	30.20	..	..	..	..
	10	46	30.22	N	moderate	..	..
	2 p. m.	47	30.22	..	..		clear
	6	43	30.29	..	..		..
	10	36	30.30	NNW	..		..
" 4..	6 a. m.	30	30.38	..	..		..
	10	34	30.37	..	..		..
	2 p. m.	39	30.35	N	..		..
	6	37	30.37	..	fresh		..
	10	33	30.47	NE	..		..
" 5..	6 a. m.	29	30.55	NNE—N	moderate		..
	10	32	30.57	N	light	NNW	fair
	2 p. m.	40	30.53	..	..	..	..
	6	38	30.50	..	..	..	..
	10	35	30.48		..		
" 6..	6 a. m.	35	30.36	WSW	..	W	cloudy
	10	38	30.36	SW by W	..	..	..
	2 p. m.	44	30.27	..	..	..	..
	6	42	30.22	..	..	..	
	10	42	30.20	SW	moderate		fair
" 7..	6 a. m.	41	30.25	..			..
	10	47	30.25	..	light		clear
	2 p. m.	52	30 26	..	..	SSW	fair
	6	51	30.26	S by W	..	W by N	cloudy
	10	50	30.28		..		..
" 8..	6 a. m.	48	30.30	SSW	..	WSW	fair and smoky
	10	54	30.28	..	..	..	.. ..
	2 p. m.	60	30.24	S—SSE	..	W by S	.. ..
	6	58	30.18	SSE	..	..	.. .. —haze at WNW
	10	38	30.15	SW	moderate	..	cloudy
" 9..	6 a. m.	57	29.00	WSW	..	..	..
	10	60	29.95	..	fr'h—strong	..	
	2 p. m.	60	29.80	..	fresh	SW by W	rainy, and clouds brisk by SW by W
	6	59	29.72	..	..	..	cloudy
	10	56	29.69	..	..	..	..



METEORIC PHENOMENA.—One of the most splendid displays of meteors, or, as they are sometimes called, "shooting stars," was visible on Wednesday, the 13th of November, in every part of the continent of America from which intelligence has been received. Most of the descriptions in the public prints agree in the main particulars. The following is from the pen of Professor Olmstead, of Yale College: for the engraving, we are indebted to Mr. Pickering, one of the editors of the "Old Countryman," who witnessed the scene, and under whose directions and instructions the prefixed representation was made.

"To form some idea of the phenomenon, the reader may imagine a constant succession of fire-balls, resembling sky-rockets, radiating in all directions from a point in the heavens near the zenith, and following the arch of the sky towards the horizon. They proceeded to various distances from the radiating point, leaving after them a vivid streak of light, and usually exploding before they disappeared. The balls were of various sizes and degrees of splendor: some were mere points, but others were larger and brighter than Jupiter or Venus, and one, seen by a credible witness, before the writer was called, was judged to be nearly as large as the moon. The flashes of light, though less intense than lightning, were so bright as to waken people in their beds. One ball that shot off in the

north-west direction, and exploded near the star Capella, left, just behind the place of explosion, a phosphorescent train of peculiar beauty. This line was at first nearly straight, but it shortly began to contract in length, and dilate in breadth, and to assume the figure of a serpent folding itself up, until it appeared like a small luminous cloud of vapor. This cloud was borne eastward by the wind, opposite to the direction in which the meteor had proceeded, remaining in sight several minutes. The light was usually white, but was occasionally prismatic, with a predominance of blue.

"A little before six o'clock, it appeared to the company that the point of radiation was moving eastward from the zenith, when it occurred to the writer to mark its place, accurately, among the fixed stars. The point was then seen to be in the constellation Leo, within the bend of the sickle, a little to the westward of Gamma Leonis, and not far from Regulus. During the hour following, the radiating point remained stationary in the same part of Leo, although the constellation in the mean time, by the diurnal revolution, moved westward to the meridian nearly 15°. By referring to a celestial globe, it will be seen that this point has a right ascension of 150°, and a declination of about 20°. Consequently, it was 20° 18′ south of our zenith.

"The weather had sustained a recent change. On the evening of the 11th, a very copious southerly rain fell, and on the 12th, a high westerly wind prevailed, by gusts. Last evening the sky was very serene: a few falling stars were observed, but not so numerous as to excite particular attention.

"As the cause of 'falling stars' is not well understood by meteorologists, it is desirable to collect all the facts attending this phenomenon, stated with as much precision as possible. The subscriber, therefore, respectfully requests to be informed of any particulars which were observed by others, respecting the time when it was first discovered, the position of the radiant point above mentioned, whether progressive or stationary, and of any other facts relating to the meteors. "DENISON OLMSTEAD.

"Yale College, Nov. 13, 1833."

In a subsequent letter to the editor of the New-Haven Daily Register, Professor Olmstead requests the favor of communications from those who witnessed the meteoric shower; and to state "particularly *from what part of the heavens the fire balls appeared to emanate;* whether they all proceeded from the same point; whether this point was stationary among the stars, and followed their diurnal motion from east to west; and near what particular star it was seen at different hours, from the beginning to the end of the observations. Should my observation, that the origin of the meteors remained stationary, following the progress of the stars, be confirmed by others who saw it for a longer time, it would show that this point was beyond the limits of the atmosphere; for otherwise it would have advanced eastward with respect to the stars, along with the atmosphere, in its diurnal revolution. Moreover, the exact position of this point, at any given time, as seen from places remote from each other, will, if correctly ascertained, afford the means, by the parallactic arc, of calculating its height above the earth. As meteorological phenomena of this class are frequently attended with irregularities of the *magnetic needle*, should any one have observed the state of the needle during its continuance, or should have detected any deviation arising from it, he would also confer a favor by communicating the facts."

The meteoric rain, as it has been forcibly denominated, has been frequently observed, although never in such showers as those of which we are now recording the account. The United States Gazette furnishes the following instance, which can, no doubt, be implicitly relied on:

"In a book recently published, called 'The Geography of the Heavens, with a Celestial Atlas,' by E. H. BARRIT, A. M., 104, 1954, an account is given of a scene similar to the above.

'Mr. Andrew Ellicott, who was sent out as our commissioner to fix the boundary between the Spanish possessions of North America and the United States, witnessed a very extraordinary flight of shooting stars, which filled the whole atmosphere from Cape Florida to the West India Islands. This grand phenomena took place on the 12th November, 1799, and is thus described: 'I was called up,' says Mr. Ellicott, 'about three o'clock in the morning to see the shooting stars, as it is called. The whole heavens appeared as if illuminated with sky rockets, which disappeared only by the light of the sun after day-break. The meteors, which at any one instant of time appeared as numerous as the stars, flew in all possible directions, except *from* the earth, *towards* which they all inclined more or less, and some of them descended perpendicularly over the vessel we were in, so that I was in constant expectation of their falling on us.'"

"A more extensive and remarkable phenomenon of this kind occurred in the night of the 12th of November, 1779. Of this appearance, as it was seen at Cumana, an accurate account has been given by M. M. Humboldt and Bonpland. It occurred towards the morning, when, we are informed, thousands of meteors, eolides, fire-balls, or falling stars, as they were variously denominated, succeeded each other during four hours. Their direction was from north to south. They rose in the horizon at east-north-east, followed the direction of the meridian, and fell towards the south. There was little wind, and this from the east. No trace of clouds was seen. There was not a space in the firmament equal in extent to three diameters of the moon which was not filled with burning stars. They were of different sizes. They left luminous traces of from five to ten degrees in length. The appearance of these traces continued seven or eight seconds. Many of these stars had a very distinct nucleus, as large as the apparent disc of Jupiter. The largest were from 1° to 1° 15′ in diameter. They are described as seeming to burst, as by explosion. Their light was white. They were seen by almost all the inhabitants of Cumana, the oldest of whom asserted their remembrance that the great earthquakes of 1766 were preceded by similar phenomena."

It is a circumstance worthy of especial notice that the phenomena observed by Humboldt and Ellicott were seen on the same day of the month (the 12th of November) in different years, and that the recent extraordinary appearance in our atmosphere took place on the 13th of the same month. If it be true, as is contended by some, that the meteors were observed before 12 o'clock on Tuesday evening, the extraordinary fact is disclosed, that this most remarkable occurrence took place on the same day of the same month at three distinct and distant periods.

We shall close our account of this extraordinary phenomena, by introducing another drawing, and soliciting the favor of communications of any of our friends and correspondents, tending to elucidate the subject.